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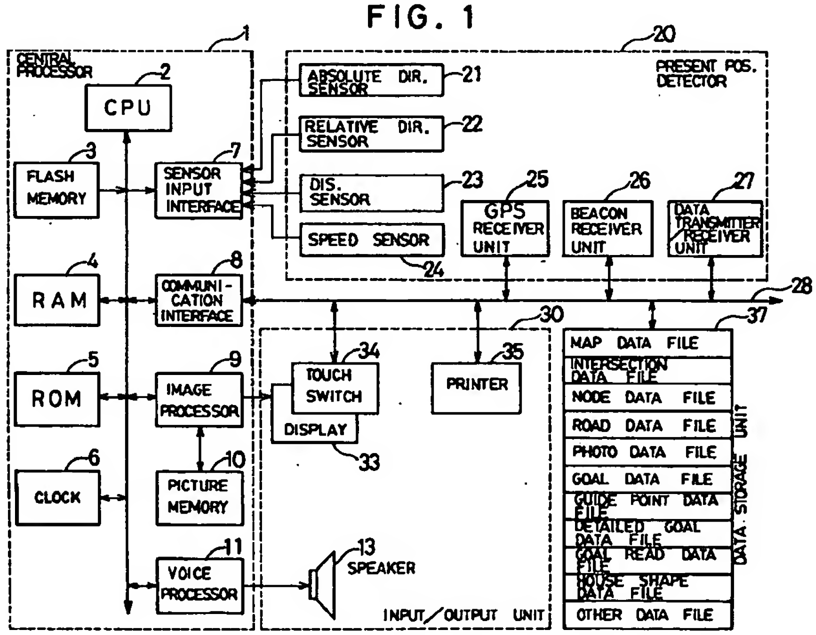
(54) **Map indication device and navigation device**

(57) Upon recognizing the shapes of buildings, buildings can be searched and destinations can be designated simply and easily. Besides, indication of the house map and the road map is changed over depending upon the predetermined conditions. This makes it easy to arrive at the destination. When the destination is indicated on the house map, a guide route is searched up to a position on a road adjacent to the building at the destination. This makes it easy to learn where in the vicinity of the destination the car is arriving at.

FIG. 1



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Description

The present invention relates to a map indication device and to a navigation device which produces the route guidance to a destination that is set by a user.

A conventional map indication device can be represented by, for example, a car navigation device mounted on a car. The car navigation device stores a plurality of items related to places such as geographical names, telephone numbers and addresses of buildings, parks, companies, etc. These items have been stored in the navigation device together with representative coordinates that specify geographical places of facilities. When an item such as the geographical name, telephone number, address or the like is specified by the user, the destination desired by the user is input to the navigation device. According to another navigation device, a particular point can be designated on the map on a picture by using a cursor. In such a navigation device, when a point which is the destination is designated by the user on the map picture using the cursor, the coordinates of the designated point are set to the navigation device as a destination point.

As described above, designating the destination using items is makes it convenient to reliably select the destination. However, the above-mentioned navigation devices require list data in which geographical coordinates of destination points are corresponded to the items such as geographical names, telephone numbers, etc. that are related to a plurality of destination points on a map. Such list data must be stored in a memory having a very large capacity. The navigation device equipped with the memory having such a very large capacity results in an increase in the cost of production.

Therefore, the conventional navigation devices have been provided with a memory of limited capacity to avoid an increase in the cost of production. That is, the list data stored in the navigation device are constituted by only those data concerned to major places. In other words, the navigation device is not storing list data related to all of the places.

Therefore, when geographical places that are not included in the list data are to be set as destinations, such destinations must be designated by a separate method such as the one in which a map picture of a region including the destination is indicated on the display of the navigation device, and the destination is designated by using a cursor on the map picture. It is, however, difficult to correctly bring the cursor to an exact point on the map picture.

In the conventional navigation device, furthermore, setting the destinations and detecting the present position of the car are effected by using a road map formed based upon road data. Besides, searching the route up to a designated destination from the present position of the car and road guidance along the searched route are informed by using the road map.

In order to offer a proper route guidance while the car is running, furthermore, the map on the display of the navigation device indicates only a minimum of data. This is to easily let the user know who is driving the car, the present position of the car and the principal roads along which he may proceed.

As described above, the conventional navigation device indicates small amounts of data and, hence, offers relatively small amounts of data from which the user must confirm the destination or a particular facility desired by the user. Accordingly, the user may often find it cumbersome to determine the exact point. With the map data constituted by the conventional road data, furthermore, the user may often overlook the destination on the displayed map despite he is approaching near the destination according to the route guidance. As a result, the user passes over the vicinity of the destination and takes a detour to arrive at the destination; i.e., the function of the navigation device is not often efficiently utilized.

In the conventional navigation device, the roads on the map indicated on the picture are constituted by straight lines coupling a plurality of coordinate points. Besides, large facilities are surrounded by lines so that the whole sites of the facilities can be recognized, and names of the facilities are often indicated on the map picture. Concerning the coordinates on the map input at the time of setting the destination, furthermore, there may often be searched a road in the vicinity of the coordinates or an intersection closest to the coordinates. The point or the intersection on the searched road is set as an end point of guidance, and a route is searched from the present position of the car to the end point.

With the facilities being surrounded by lines as described above, however, it is not often obvious on the picture where the entrance of the facility is. Moreover, since the end point of guidance is set and the guide route is searched based on the input point, the route is favorably guided up to the vicinity of the destination. When the surrounding of the facility at the destination has a complex shape, however, the user is often finally guided to the back door or to a byroad of the facility at the destination.

The present invention was accomplished in order to solve the above-mentioned problems.

A first object of the present invention is to provide a navigation device which makes it possible to simply and easily search buildings and to designate destinations by recognizing the shapes of buildings.

A second object of the present invention is to provide a navigation device which indicates guidance while running and makes it easy to determine a point on a map that is indicated.

A third object of the present invention is to provide a navigation device which is capable of automatically changing the indication of house maps and road maps depending upon the predetermined conditions.

A fourth object of the present invention is to provide a navigation device capable of calculating a suitable route to the destination.

A fifth object of the present invention is to provide a

navigation device which, when the destination is indicated on a house map, automatically sets a guide route to a point on a road adjacent to a building which is the destination.

According to the present invention, the shape of a building is formed as data and is stored, making it possible to easily recognize the shape of the building. This makes it possible to search the building at a point that is input, and the user is able to quickly and easily execute the operation for inputting a desired building which is the destination. Moreover, the shape of the building is indicated on the picture using the data related to the shape of the building. Therefore, the present point that is indicated can be easily recognized, and the user is able to easily recognize the present point.

According to the present invention, further, the indication of the road maps and the house maps is changed over depending upon running condition of the car, and the guide route can be watched more easily while the route is being guided. Under given running conditions of the car, furthermore, the point can be easily confirmed. Moreover, since provision is made of means capable of selecting the indicated contents of map data, the user finds it easy to recognize a point such as destination on the indicated map when such a point is set.

According to the present invention, moreover, the house map is automatically indicated on the picture when the car has arrived at the vicinity of the destination, making it possible to property recognize the position of the destination on the map. As a result, the user is able to arrive at the destination quickly and easily. When the car is running at a speed faster than a predetermined speed, furthermore, the road map is automatically indicated on the picture, making it possible to watch the map more easily while running. When it is desired to confirm a place of the building on the indicated map, a house map is indicated under the condition where the car is running at a speed slower than a predetermined speed, and the building can be easily recognized.

According to the present invention, a point on the road adjacent to the building which is the destination is indicated as an end point of road guidance, and a guide route for arriving at this end point is searched. This eliminates such a probability that the end point of the guide route is erroneously set on the road remote from the destination. Besides, the road is guided up to just before the destination, and the user is able to know where his car is located in the vicinities of the destination by viewing the figure that represents the shape of the house which is the destination indicated on the house map.

The ward "buildings" include "facilities" except "buildings". The ward "destination" includes "goal" except "destination". The ward "indicate" includes "show" and "display" except "indicate".

Fig. 1 is a circuit diagram illustrating a whole navigation device;
Fig. 2 is a diagram illustrating an indication of a road map;
Fig. 3 is a diagram illustrating an indication of a house map;
Fig. 4 is a diagram illustrating some of data stored in a RAM 4;
Fig. 5 is a diagram illustrating the contents of house shape data;
Fig. 6 is a diagram of data related to the shape of a house;
Fig. 7 is a diagram of a flow chart illustrating the whole processing executed by the navigation device;
Fig. 8 is a diagram of a flow chart illustrating a processing for setting a destination;
Fig. 9 is a diagram of a flow chart illustrating a processing for designating a destination;
Fig. 10 is a diagram illustrating a cursor KL and a form of the house shape;
Fig. 11 is a diagram indicating a list of detailed data related to the house shapes;
Fig. 12 is a diagram illustrating some of data stored in the RAM 4;
Fig. 13 is a diagram of a flow chart illustrating a processing for designating a destination;
Fig. 14 is a diagram of a flow chart illustrating a processing for switching the map;
Fig. 15 is a diagram of a flow chart illustrating a processing for manual operation;
Fig. 16 is a diagram of a flow chart illustrating a processing for switching when the destination is approached;
Fig. 17 is a diagram of a flow chart illustrating a processing for switching into a house map;
Fig. 18 is a diagram of a flow chart illustrating a processing for setting a place to be dropped in;
Fig. 19 is a diagram illustrating a color indication and a solid indication of a house shape;
Fig. 20 is a diagram illustrating some of data stored in the RAM 4;
Fig. 21 is a diagram illustrating the contents of a road data file;
Fig. 22 is a diagram illustrating a guide route;
Fig. 23 is a diagram illustrating the constitution of road number data;
Fig. 24 is a diagram illustrating the contents of house shape data;
Fig. 25 is a diagram illustrating a relationship between the house shape at the destination and the adjacent roads;
Fig. 26 is a diagram illustrating a relationship between the house shape at the destination and the roads when the adjacent roads are the ones that are not guided;
Fig. 27 is a diagram of a flow chart illustrating a processing for searching the route;
Fig. 28 is a diagram of a flow chart illustrating a processing for determining a start point of route;
Fig. 29 is a diagram of a flow chart illustrating a processing for determining an end point of route;

Fig. 30 is a diagram of a flow chart illustrating a processing for searching a guide route;

Fig. 31 is a diagram of a flow chart illustrating a processing for designating an arrival point according to a fourth embodiment;

Fig. 32 is a diagram of a flow chart illustrating a processing for determining an end point according to the fourth embodiment;

Fig. 33 is a diagram of a flow chart illustrating a processing for searching a guide route according to the fourth embodiment;

Fig. 34 is a diagram of a flow chart illustrating a processing for determining the end point according to a fifth embodiment;

Fig. 35 is a diagram of a flow chart illustrating a processing for searching a guide route according to the fifth embodiment;

Fig. 36 is a diagram of a flow chart illustrating a processing for setting a point according to a sixth embodiment; and

Fig. 37 is a flow chart of a processing for searching a route according to the sixth embodiment.

PRO.:PROCESSING, DIR.:DIRECTION, DIS.:DISTANCE, DISS.:DISTANCES, CLA.:CLASSIFICATION, POS.:POSITION, No.:NUMBER, IND.:INDICATE, INDD.:INDICATED, INDN.:INDICATION, PREP.:PREDETERMINED, PAR.:PARTICULAR, DES.:DESTINATION, DET.:DETERMINE, DETG.:DETERMINING, DETD.:DETERMINED.

A data storage unit 37 stores the house shape data (Fig. 5) surrounded by a plurality of straight lines and representing the shape of a place sectionalized on a plane. A destination can be designated by using a cursor KL on a picture indicated on a display 33. In this case, the coordinates of the center KLC of the cursor are found on the picture (step 96 in Fig. 9). The house shape data including coordinates of the center KLC of the cursor within the section are searched (step 98). A geographical place represented by the house shape data including coordinates of the center KLC of the cursor is designated as a destination. Therefore, the destination can be set more easily by utilizing the house shape data than by bringing the center KLC of the cursor into agreement with the coordinates on the picture.

When a given item is selected from a list of a plurality of items indicated on the picture, a destination meeting to the item is automatically selected. Then, a house map of a range including the selected destination is indicated on the display 33 (step 76 in Fig. 8, step 92 in Fig. 9). When a picture range including the destination, present position and center of cursor at the center of the picture, does not lie within a coordinate range of the house map, a road map is indicated instead of indicating the house map (steps 90 and 94 in Fig. 9). The map picture indicated on the display 33 can be switched to either a house map or a road map through manual operation (step 220 in Fig. 14). When the present position is within a predetermined distance of the registered destination TP, a house map is automatically indicated on the display 33 (step 222 in Fig. 14). When the car is coming to a halt or is running at a speed slower than a predetermined speed, indication of the house map is inhibited (step 60 in Fig. 8, steps 292 and 294 in Fig. 17). When the road map is changed over to the house map, a reduced scale of the road map is stored (step 302 in Fig. 17). When the house map is changed over again to the road map, the indication is made on this stored scale (steps 312 and 314 in Fig. 17).

The house shape data file (Fig. 5) includes data (adjacent road data) related to roads adjacent to the house shape. When the destination designated by the user consists of house shape data (step 492 in Fig. 29), the coordinate of a node included in the adjacent road data in the house shape data is regarded to be an end point (step 496 in Fig. 29). Then, a guide route arriving at the end point is searched (step 464 in Fig. 27). Thus, there is set a guide route to the end point on the road adjacent to the house shape which is the destination (steps 526, 544 in Fig. 30).

1. First Embodiment

Described below are the features of a map indication device according to a first embodiment of the present invention. The map indication device of the first embodiment stores data related to a building such as shape and name of the building (house shape data file). Based upon this data, a map is indicated (step 92 in Fig. 9) and the shape of the indicated building is recognized (shape data). In the first embodiment, furthermore, a building corresponding to a point that is input is searched and is informed (step 98 in Fig. 9).

The map indication device of this embodiment that will be described below comprises a storage means (house shape data file) for storing external data of buildings such as planar shapes or solid shapes of a plurality of buildings and sites, reading means (CPU 2) for reading the external data of the buildings stored in the above storage means, a conversion means (image processor 9) for converting the external data of the buildings read by the above reading means into data for indication, and an indication means (display 33, step 92 in Fig. 9) for indicating a map that shows external data of buildings based upon the external data of the buildings converted by the conversion means. A feature resides in that the shape of a building is recognized on the map indicated by the indication means.

Furthermore, the map indication means of the embodiment that will be described below comprises an external data storage means (house shape data file) for storing external data of buildings such as shapes of buildings, an internal data storage means (detailed data of Fig. 5) for storing internal data such as addresses, names, telephone numbers, etc. of the buildings in relation to the external data of the buildings stored in the external data storage means, an indication means (display 33, step 92 in Fig. 9) for indicating a map that

shows external data of buildings based upon the external data of the buildings stored in the external data storage means, a discrimination means (step 98 in Fig. 9) for discriminating the shape of the building from the map showing external data of buildings indicated by the indication means, a searching means (step 102 in Fig. 9) for searching, from the internal storage means, the internal data related to the building determined by the discrimination means, and an informing means (step 102 in Fig. 9) for informing the internal data of the building searched by the searching means.

Moreover, the map indication device of the embodiment that will be described below comprises a house shape data storage means (house shape data file) for storing data related to buildings such as shapes of buildings, an indication means (display 33, step 92 in Fig. 9) for indicating map data based upon the data stored in the house shape data storage means, a point input means (cursor KL, step 96 in Fig. 9) for inputting a point based on the data indicated on the indication means, and a house shape searching means (step 98 in Fig. 9) which recognizes the shape of a building based on the house shape data storage means and searches a building that corresponds to the point input by the point input means, and wherein the indicator means informs a building that corresponds to a point input by the input means (step 53 in Fig. 7).

A navigation device of the embodiment that will be described below comprises a present position detection means (step 50 in Fig. 7) for detecting the present position of the car, a house shape data storage means (house shape data file) for storing shapes of building in the form of a coordinate sequence, an indication means (display 33, step 92 in Fig. 9) for indicating map data based on the data stored in the house shape data storage means, a point input means (cursor KL, step 96 in Fig. 9) for inputting a point based upon the data indicated on the indication means, a house shape searching means (step 98 in Fig. 9) which compares the coordinates of the point input by the input means with the shape of a building formed by the coordinate sequence of the house shape data storage means, renders the decision and searches a building that corresponds to the coordinates of the point that is input, a destination setting means (step 108 in Fig. 9) for setting, as a destination, the building searched by the house shape searching means, and a route operation means (step 52 in Fig. 7) for operating a route from the present position to the destination set by the destination setting means, wherein the indicator means informs a building that corresponds to the coordinates of the point input by the input means (step 53 in Fig. 7) and further informs the route operated by the route operation means (step 53 in Fig. 7).

Moreover, the navigation device of the embodiment that will be described below comprises a house shape data storage means (house shape data file) for storing house shape data related to the house shape representing the shapes of places sectionalized on a plane in a predetermined region, positions of the places and data related to the places, a destination designation means (cursor KL) for designating a place of destination by a point, a coordinate searching means (step 96 in Fig. 9) for searching the coordinates of a point designated by the destination designation means, a house shape searching means (step 98 in Fig. 9) for searching the house shape data in which are included the coordinates of the place searched by the coordinate searching means, a destination setting means (step 108 in Fig. 9) which regards the place represented by the house shape data searched by the house shape searching means to be a destination, a guide route setting means (step 52 in Fig. 7) for setting a guide route up to the destination that is set by the destination setting means, an indication means (display 33) for indicating a picture, a data indication means (step 102 in Fig. 9) for indicating, on said indicator means, the house shape data related to a place included in the house shape data searched by the house shape searching means, a present position detection means (step 50 in Fig. 7) for detecting the present position of a moving means, and a route indication control means (step 53 in Fig. 7) for indicating, on the indicator means, the guide route set by the guide route setting means and the present position detected by the present position detection means.

2. Overall Circuitry.

Fig. 1 shows the overall circuitry of the navigation device. A central processor 1 is equipped with a CPU 2 which controls the operation and executes the operation of the whole navigation device. The central processor 1 is provided with a first ROM 3, a RAM 4, a ROM 5, a clock 6, a sensor input interface 7, a communication interface 8, an image processor 9, a picture memory 10 and a voice processor 11.

The flash memory 3 stores a system program executed by the CPU 2, programs for controlling the indication and for controlling the voice guidance, as well as a variety of parameters. The RAM 4 is storing data input from external units, a variety of parameters used for the arithmetic operation, and the operated results.

The ROM 5 is storing data to be indicated necessary for guiding the routes and for indicating the maps. The clock 6 generates time data. The sensor input interface 7 receives a variety of detection data from an absolute position sensor 21, a relative position sensor 22, a distance sensor 23 and a vehicle speed sensor 24 in a present position detector 20. The detection data from the present position detector 20 are sent to the CPU 2 through the sensor input interface 7. The communication interface 8 controls the communication of various data that are exchanged between a unit connected to a data bus 28 and the central processor 1.

The image processor 9 reads picture data stored in the picture memory 10, writes picture data thereon, and controls the indication of picture on a display 33. The display 33 may be a CRT, a liquid crystal display or a

plasma display. The picture memory 10 stores the picture data to be indicated on the picture of the display 33, and exchanges the picture data relative to the image processor 9. In response to an instruction from the CPU 2, the image processor 9 converts map data into data for indication, and forms picture data to be displayed on the picture on the display 33.

In this case, picture data are formed having a range larger than the picture size which can be indicated at one time on the display 33, and are stored in the picture memory 10. Therefore, even when the picture of the display 33 is scrolled in the longitudinal direction or in the transverse direction, the map picture is quickly indicated. The ROM 5 is storing voice waveform data by recording synthetic voice or natural voice for guidance by voice. Being controlled by the CPU 2, the voice waveform data that are required are read out from the ROM 5 and are sent to a voice processor 11 which converts the voice waveform data that are input into voice signals of analog waveforms and outputs them to a speaker 13.

The present position detector 20 detects the present position of the car. The detection data are sent to the central processor 1 from the present position detector 20 which includes an absolute direction sensor 21, a relative direction sensor 22, a distance sensor 23, a car speed sensor 24, a GPS receiver unit 25, a beacon receiver unit 26, and a data transmitter/receiver unit 27. The absolute direction sensor 21 is a terrestrial magnetism sensor for detecting terrestrial magnetism in the direction of magnetic field of the earth. The absolute direction sensor 21 outputs data that represent south-and-north position which is the absolute bearing that is detected.

The relative direction sensor 22 outputs data that represent a deviation of the direction in which the car is traveling from the absolute direction detected by the absolute direction sensor 21. The relative direction sensor 22 is made up of a gyroscope such as an optical fiber gyroscope or a piezo-electric oscillation gyroscope, or a steering angle sensor for detecting the steering angle of the wheels. The distance sensor 23 outputs data that represent the distance traveled by the car and is, for example, a digital counter interlocked to, for example, an odometer. The car speed sensor 24 outputs a voltage signal or a digital signal that varies in proportion to the running speed of the car.

The GPS receiver unit 25 receives a plurality of electromagnetic wave signals emitted from the GPS (global positioning system) and finds the present position of the car upon arithmetic operation by using the electromagnetic wave signals. The GPS receiver unit 25 outputs data indicating the present position of the car. The GPS is constituted by a plurality of artificial satellites orbiting in space outside the atmosphere of the earth. The beacon receiver unit 26 receives correction data of GPS sent from a ground station and from a data offering system such as VICS (road traffic data communication system) or the like. The received data are sent to the central processor 1 from the beacon receiver unit 26. The data transmitter/receiver unit 27 exchanges a variety of data between the car and the bidirectional present position data offering system or the ATIS (traffic data service), etc. by utilizing a cellular phone, FM multiplex signals or a telephone circuit.

The input/output device 30 is used for inputting data necessary for setting the destination, such as start point, destination, passing point, etc., and informs guide data during the navigation operation. A transparent touch panel 34 is provided on the picture of the display 33. The touch panel 34 is constituted by transparent touch switches that are arranged in the form of a matrix on a plane. A printer 35 is used for printing a variety of data such as a map and a guide to facilities output through the communication interface 8. The printer 35 will be omitted depending upon the cases.

Programs according to attached flow charts described later, for navigation process which are executed by CPU 2 and programs which relate to the other process are memorized in the data storage unit 37. These programs are read (installed / transferred / copied) from the data storage unit 37 (outside memory means / medium) and written and stored to the flash memory 3 (inside memory means / medium). This installing (transferring / copying) is executed automatically by setting the data storage unit 37 to the navigation device or powerring on the navigation device or instruction (operation) of operator.

The data storage unit 37 can be exchanged for other data storage unit, therefore these programs and data can be exchange for the other newer or the newest programs and data. Accordingly the newest navigation system can be given by the exchanging.

The data storage unit 37 stores various data such as map data, intersection data, node data, road data, photographic data, destination data, guide point data, detailed destination data, destination read data, house shape data, indication guide data, voice guidance data, picture data showing simple guide route, etc. that are necessary for the navigation operation. The data storage unit 37 is constituted by a data recording medium such as an IC memory, a CD-ROM, an IC memory card, an optical disk, or a magnetic disk, and a reader unit therefor.

The map data file stored in the data storage unit 37 includes road map data such as road map of the whole of the country and house map data from which the shapes of buildings can be recognized. The road map and the house map may be constituted by a plurality of maps of different reduced scales for the same region, or may be constituted by a piece of map of a required reduced scale. In this embodiment, the road map and the house map are constituted by a plurality of map data of different reduced scales for each of the regions. Besides, the house map has been stored as a collection of data of buildings for particular areas (e.g., cities, towns, villages only).

The road map is the one indicating road networks, characters, signs or figures representing places of prin-

cipal buildings or facilities, principal map signs representing railroad crossings, bridges, etc., and geographical data such as geographical names of cities, towns, villages, etc. Fig. 2 illustrates a picture indicated based upon the road map data having the largest scale. The largest scale stands for that the facilities, etc., are indicated in the greatest size on the picture on the display 33. In the indicated picture of road map based upon the road data, the roads are distinguished by lines having different thicknesses and colors. The principal buildings and facilities have a symbol mark attached to the coordinates where they exist. As for other data, there are indicated, on the picture, names of buildings or facilities, names of principal roads, names of the regions, and marks of road regulations such as one-way, etc., though they are not diagramed.

The house map indicates the shapes of houses representing the shapes of roads, rivers, buildings, facilities above ground, etc. as figures on a correct reduction of the practical sizes. The house map further indicates geographical data, too. Fig. 3 shows a house map. As shown in Fig. 3, the data of house map are so constituted that the scale is smaller than the smallest reduction scale of the road map or is the same as the smallest reduction scale of the road map. In the house map, therefore, the widths of the roads are correct reductions of the widths of the practical roads. The house map shows sidewalks, pedestrian bridges, etc. The house map further indicates marks representing traffic signals at the intersections, and map signs representing fields, pasture lands, etc. Though not diagramed, furthermore, the house map further indicates names of buildings and facilities, names of principal roads, names of the areas, and signs of road regulations. The house map data recorded in the data storage unit 37 are for indicating the house map on the display 33.

Here, the house shape constitutes data for discriminating the outer shapes of buildings above ground. That is, the "house shape" represents planar shapes of sections, buildings and sites on a place sectionalized on a plane or solid appearance thereof on a place expressed on a plane such as a perspective view or the like view. Though expressed as "house shape" for the purpose of easy explanation, the house shape data includes places other than the houses, such as sites of facilities, roads, and rivers.

The intersection data file of the data storage unit 37 are constituted by data related to intersections such as positions and names of the intersections. The node data file is constituted by a group of data such as coordinates of a plurality of nodes set on the roads. The nodes stand for those that are formed when the roads on the road map are approximated as straight lines. The road data file is constituted by the positions and kinds of roads, number of lanes, and data representing connections among the roads. The photographic data file is constituted by photographic picture data of places where visual expression is required such as of facilities, sight-seeing resorts, principal intersections, etc.

The destination data file is constituted by places that have been set as destinations such as principal sight-seeing resorts, buildings, enterprises listed in a telephone book, places of business, geographical positions of facilities, and data related to the destinations such as names of the facilities. The guide point data file is constituted by guide data related to roads. The guide data include contents of guide boards practically installed along the road, and data necessary for guiding the roads such as guides at branching points. The detailed destination data file is constituted by detailed data related to destinations stored in the destination data file.

The destination read data file is constituted by list data for phonetically searching the destinations in the destination data file. The house shape data file is constituted by shape data of house shapes for indicating the outer shapes in response to the house map data, and discrimination data that accompanies the house shapes. Other data file may include an address list data file for searching the destinations from the addresses, a telephone number list data file for searching the destinations from the telephone numbers, a data file related to destinations which are personally registered by the user, and the like file. The destinations personally registered by the user may be places that are frequently set as destinations such as places of clients, customers, etc.

3. Data Groups.

Fig. 4 illustrates some of the data groups stored in the RAM 4. Onto the external data GD are copied whole or part of the data stored in the data storage unit 37. The present position data MP are present position data of the car detected by the present position detector 20. The absolute direction data ZD are data representing the south-north direction found based upon the data from the absolute direction sensor 21. The relative direction angle data represent an angle subtended by a travelling direction of the car found based upon the data from the relative direction sensor 22 with respect to the absolute direction.

The travelled distance data ML represent a distance travelled by the car found based upon the data from the distance sensor 23. The present position data PI are data related to the present position input through the beacon receiver unit 26 or the data transmitter/receiver unit 27. The VICS data VD and the ATIS data AD are the data of VICS or ATIS input through the beacon receiver unit 26 or the data transmitter/receiver unit 27.

The registered destination data TP are data related to the position or name of a destination registered by the user. The guide route data MW are the data representing the best route or a recommended route up to the destination searched through a route searching processing (step 52) that will be described later. Start-point-of-route data SP are coordinate data on a map of

a point from where the navigation operation starts, the start point being determined by the route searching processing (step 52). The end-point-of-route data EP are coordinate data on a map of a point at where the navigation operation ends, the end point being determined by the route searching processing (step 52).

4. House Shape Data.

As described above, house map data have been furnished for wards of major cities, towns and villages, and a house map number has been attached to each of the sections. The house shape data are sectionalized for each house map number of the area where the house shapes exist. As described above, furthermore, the house shape data are constituted by the data related to the outer shapes of houses and data for discriminating the places. To the discrimination data are related kind data representing the purpose for using the facility, data of adjacent roads, detailed data, etc. In this embodiment, the shape data represent planar shapes of sections, sites and buildings at places where buildings and facilities existing in the house map are sectionalized on a plane.

Fig. 5 illustrates house shape data of a section stored in the house shape data file. The house map number data are in agreement with number data of house map data stored in the map data file. The data related to the number of data represent the number N of house shapes existing in a section represented by a house map number. The house shape data of a number N each include kind data, shape data, data of adjacent roads, detailed data and other data. Among them, the shape data are external data of buildings. The data other than the shape data are internal data of the buildings.

The kind data are those data for specifying public facilities such as government offices, schools, hospitals, etc. and for specifying the kinds of buildings such as individual houses, apartments, single-family houses, etc. The kind data further include data representing the kinds of places sectionalized by road, railway or boundary such as river. The shape data are constituted by the collection of data of geographical coordinate sequence for forming the house shapes. That is, a single house shape is indicated by a figure which surrounds the house shape using straight lines. Therefore, the shape data is constituted by a required number of coordinates and coordinate data at vertexes which are points where the straight lines are coupled together. When the house has, for example, a hexagonal shape as shown in Fig. 6, the coordinates (X0, Y0) to (X5, Y5) at the vertexes form coordinate data for indicating the shape of the house. Curves of the house shape can be approximated by fine straight lines. Therefore, the house having curved outer shape has increased number of vertexes.

The data related to adjacent roads are constituted by the number data of roads adjacent to the house shape and the coordinate data of nodes included in the data of the adjacent roads. A plurality of nodes adjacent to the house shape are often selected as nodes set to the data of the adjacent roads. When a plurality of roads are adjacent to the house, the data of the adjacent roads include number data of those roads and coordinate data of the nodes. The detailed data represent detailed contents related to a house shape. When the kind of the house shape is, for example, a building housing a number of independent business institutions, the detailed data include the name of the place such as the name of the building, address data of that place, data related to the number of stories of the building, data related to the number of companies or departments in the building, and data related to the contents of the companies or departments. The address data are those representing metropolis and states, districts, wards, towns, villages, streets, and addresses.

The content data include name data such as names of companies and names of departments, telephone number data, section data, and classification data. The classification data represent the contents of businesses. The classification method used in the classification data is determined in compliance with classification of businesses listed in a classified telephone directory. Concrete classifications include gas stations, restaurant, convenience stores, parking lots, police boxes, drug stores, banks, post offices, stations, hospitals, schools, movie theaters, halls, theaters, live houses, art museums, libraries, data libraries, animal houses, aquariums, plant houses, recreation grounds, bowling alleys, skating rinks, disco clubs, karaoke shops, sports facilities, hotels, inns, sleeping accommodations, department stores, shopping centers, book stores, CD and video shops, sports shops, miscellaneous goods shops, gourmet shops, companies in general, etc.

Other data include list picture data for indicating detailed data on the display 33, solid indication picture data for three-dimensionally indicating the shapes of houses, data representing features of buildings, coordinate data at the entrances of buildings, coordinate data at the entrances of parking lots belonging to the buildings, etc.

5. Overall Processing.

Fig. 7 is a flow chart illustrating the overall processing executed by the CPU 2. This processing starts upon closing the power source circuit and ends upon breaking the power source circuit. When the overall processing starts, the CPU 2 initializes the RAM 4, picture memory 9, etc. Then, a present position-obtaining processing (step 50), an object-setting processing (step 51), a route search processing (step 52), and a guidance indication processing (step 53) are executed repetitively.

The present position-obtaining processing (step 50) obtains the present position of the car through the operation by using data sent from the present position detec-

tor 20. In the present position operation processing, the longitude and latitude representing the present position of the car are found by using the data input from the GPS receiver unit 25. The longitude and latitude are stored in the RAM 4 as the present position data MP. The present position data MP are corrected by data related to the present position input from the beacon receiver unit 26 or the data transmitter/receiver unit 27.

The operation for specifying the position of the car is executed based upon the absolute direction data ZD, relative direction angle data θ, and travelled distance data ML. The position of the car found through this operation is collated with the map data in the external data GD, and is so corrected that the present position is correctly indicated on the map picture. This processing makes it possible to correctly find the present position of the car even when the GPS signals cannot be received because the user is running through tunnels or due to any other reason.

In the destination-setting processing (step 51), the destination is set through the manipulation by the user. The destination is directly designated by the user on the picture indicated on the display 33 or is determined as the user selects any desired place from a separate list. After the destination is determined, the user designates that the destination is confirmed. Through this manipulation, the data related to the confirmed destination are stored, as registered destination data TP, in the RAM 4. After executed once, the destination-setting processing (step 51) is not executed unless the next new destination is set.

The route search processing (step 52) searches the guide route up to the destination based upon the registered destination data TP, present position data MP and road data. The guide route is constituted by the roads on the road map linking the present position to the destination. The road number data of roads constituting the guide route are arranged in the order of roads from the start point to the destination. The thus arranged road number data are stored, as guide route data MW, in the RAM 4. When the user wishes to travel from, for example, a start point to a destination, the user designates the destination in the destination-setting processing (step 51). The destination that is designated is a registered destination. The registered destination or a point on the road that is guided and is close to the destination, is stored, as an end point of route EP, in the RAM 4. The present position of the car becomes a start point. The present position or a point on a road that is guided and is close to the present position, is a start point of route SP.

The roads most adapted to the conditions for linking the start point of route SP to the end point of route EP, are successively searched. The course constituted by the thus searched roads is a guide route. Described below are the conditions used for searching the roads. That is, a condition in which the distance becomes shorter to the end point of route EP, a condition in which the time is shortened to arrive at the end point of route EP, a condition in which the route is preferentially constituted by express ways and major high ways and the like conditions.

The roads constituting the guide route are selected as described below. First, the start point of route SP is a start point for searching the guide route. A road meeting the above-mentioned conditions is selected out of a plurality of roads linked to the start point. Next, a road meeting the above-mentioned conditions is newly selected out of a plurality of roads linked to the end points of the above selected roads. This processing is repeated to search a route that is connected to the end point of route EP. The roads are those linking the two intersections or the two points. Therefore, no branching point exists on the road to which a road number is attached.

The road number data of the roads constituting the searched guide route are stored, as guide route data MW, in the RAM 4. The guide route search processing is equal to the processing for operating the road numbers constituting the guide route based on a predetermined processing by using road data defined for the roads.

In the next guidance indication processing (step 53), the route search processing (step 52) is automatically executed in case the present position of the car has deviated from the guide route. This searches a new guide route. The processing for searching the new guide route may be executed upon a predetermined switching operation or in response to a voice input. However, the route search processing (step 52) is not executed again unless the present position of the car has deviated from the guide route or an instruction is input by the user to search the route again.

In the guidance indication processing (step 53), the guide route found by the route search processing (step 52) is indicated by a thick line of a conspicuous color such as red, blue, etc. on the map picture on the display 33. Moreover, a present position mark representing the present position of the car and a destination direction mark representing the direction of the destination relative to the present position, are indicated on the picture on the display 33. Guidance information by voice is produced from a speaker 13, or guide information is indicated on the map picture on the display 33. Owing to the thus produced information, the user is able to drive his car along the guide route.

The picture for indicating the guide route utilizes a road map which includes geographical data such as roads in the vicinities of the present position, facilities, etc. and a house map in the vicinities of the present position. Instead of the road map, there may be used a simplified guide route picture without indicating geographical data but indicating only a minimum of data such as guide route, direction of destination, present position, etc.

When the car has approached a guide point that has been determined in advance, furthermore, a map near the guide point is indicated on an enlarged scale,

and the direction is indicated in which the car should travel. Moreover, guide information by voice is produced together with the indication of the map of an enlarged scale. The predetermined guide point may be a point where the user should turn to the right, to the left, or an intersection. The present position of the car indicated on the picture is corrected as the car proceeds. Therefore, the map picture indicated on the display 33 is automatically scrolled accompanying the motion of the present position of the car.

In this guide indication processing (step 53), furthermore, the picture that is indicated is changed over from the road map or from a simple guide route picture into a house map, or from a house map into a road map or into a simple guide route picture. The map is changed over in response to the manual operation by the user or automatically.

When the running speed of the car is faster than a predetermined speed, either a road map or a simple guide route picture is indicated. Conversely, when the running speed of the car becomes lower than the predetermined speed or the car comes into a halt, the road map or the simple guide route picture is changed over to the house map. When the coordinates of the present position are deviated out of the coordinate range covered by the house map that is being indicated, the road map or the simple guide route picture in the vicinities of the present position is automatically indicated. When the car has entered into a range of a predetermined radius with the registered destination as a center, the map indicated on the display 33 may be automatically changed over to the house map from the road map or from the simple guide route picture.

6. Destination-Setting Processing.

Fig. 8 is a flow chart of the destination-setting processing (step 51). It is first determined whether the car is halting or not (step 60). Concretely speaking, it is determined whether the running speed of the car detected by the car speed sensor 24 is 0 kg/h or slower than a predetermined speed. When it is determined that the car is not halting, the destination-setting processing (step 51) ends, and the next route search processing (step 52) is executed.

On the other hand, when it is determined at the step 60 that the car is halting, it is determined whether a list is input by the user or not (step 62). When the list is input, a desired item is designated from the list of items indicated on the picture. That is, when the list is input, items necessary for searching the destination are designated. Then, a destination that meets the designated items is selected. Concretely speaking, as the destination-setting processing (step 51) is started, the road map in the vicinities of the present position is indicated on the display 33. Moreover, characters "LIST INPUT" are indicated on the road map picture. When the user touches the indicated portion with his finger, a touch signal is output from the touch switch 34. The CPU 2 detects the touch signal, and a list input flag is set.

At the step 62, it is determined whether the list input flag has been set or not. When the list is input, i.e., when the list input flag is set, the display 33 indicates a menu for searching the destination, such as "address", "telephone number", "genre", etc. When the user touches a portion where there are indicated desired items, a touch signal is output from the touch switch 34. The flag of a corresponding item is set in response to the touch signal. For example, when the item of "address" indicated on the screen is touched, an address flag is set. When other items are designated, a telephone number flag, a genre flag and the like flags are set depending upon the designated items.

At the steps 64 to 68, it is determined which flags are being set. A character "RETURN" is also indicated on the menu picture on the display 33. When the character "RETURN" is touched, the destination-setting processing (step 51) ends, and the list of items is erased from the picture on the display 33. As the indication of list is erased, the road map is indicated again. The item of list input is not limited to the one mentioned above but may be the "name" of a company or a facility or the "name of an individual person". Any item may be employed provided it helps discriminate a destination over other facilities.

When any item is selected by the user out of the menu picture, a picture for data input corresponding to the selected item is indicated on the display 33 (step 74). The picture for data input is indicated based upon the destination data file and the detailed destination data file. When, for example, an item of "ADDRESS" is selected, the names of metropolis and districts are first, indicated on a list. When the name of the metropolis or district is selected from the list, then, a list of the names of cities, towns and villages is indicated on the picture. When the city, town or village is selected, then, a picture is indicated for inputting the name of a section, street number, etc. Thus, the address is input successively. Or, the address is searched and designated successively using the first letters of the words as key words. In either way, upon touching the name or the numeral that is indicated, the name or the like of the indicated portion is input to the device.

When an item "PHONE NUMBER" is selected, numerals 1 to 0 are indicated on the picture. When the indicated numerals are touched by the user, the touched numerals are input to the device. By selectively inputting the numerals, therefore, a telephone number is input.

When an item "GENRE" is selected, a list of the names of genres is indicated. When the genre name is touched on the picture, the genre of the name is set as the genre desired by the user. As the genre is selected, the names of places meeting the selected genre are indicated on the display 33 being arranged in the alphabetical order or in the order of metropolis and districts. The user touches the picture to select a desired place. After the items are thus successively selected, the user

finally selects a desired destination. The designated destination is stored in the RAM 4 (step 76). The coordinate data of each of the places in the destination data file are the data for designating coordinates of a particular point determined for each of the places like center coordinates of the site of the place.

When indication of the house map is requested at a moment when the destination-setting processing (step 51) is started, the result of discriminating the condition becomes "YES" at a step 78. In this case, a "destination designation processing" is executed (step 80) to designate a destination in the house map. The processing at the step 80 is the same as that of the step 76. When the house map of the area desired by the user to be indicated has not been stored in the data storage unit 37, a road map is indicted at the steps 80 and 76. Then, the destination is designated by using the road map. The switch for setting the destination may be the one other than the above-mentioned touch switch 34. For instance, there may be used a push-button switch provided neighboring the picture or the cursor indicated on the display 33.

7. Destination Designation Processing.

Fig. 9 is a flow chart illustrating the destination designation processing at the steps 76 and 80. In this processing, the house map is indicated on the display 33 when the house map of a region desired by the user has been stored in the data storage unit 37. Then, a place designated by using the cursor on the picture on the display 33 is searched by utilizing the house shape data. The place that is searched is stored, as the registered destination TP, in the RAM 4. When requested by the user, furthermore, detailed data of a place designated by using the cursor can be indicated on the display 33.

The flow chart of Fig. 9 will now be described. It is, first, determined whether the house map of the region desired to be indicated has been recorded in the data storage unit 37 or not (step 90). In the "destination designation processing" executed by the step 76, it is determined whether the house map data of a region inclusive of coordinates of a particular place selected at the step 74 have been stored in the data storage unit 37 or not. In the "destination designation processing" executed at the step 80, it is determined whether the house map data of a region inclusive of the present position of the vehicle have been stored in the data storage unit 37 or not. When the picture is scrolled, furthermore, it is determined whether the house map data inclusive of coordinates of the cursor at the center have been stored in the data storage unit 37 or not.

Whether the house map data have been stored in the data storage unit 37 or not is determined as described below. That is, when the house map of the region desired by the user is to be indicated on the picture on the display 33, it is determined whether the house map data can be written into the whole video memory which constitutes the picture. When the house map data for being written into the video memory have not been stored in the data storage unit 37, therefore, the house map cannot be properly indicated on the picture on the display 33. This means that the house map data of the region desired by the user have not been stored in the data storage unit 37. As described above, when the house map is not property indicated on the picture on the display 33 or, in other words, when the house map data of the region desired by the user have not been stored in the data storage unit 37, the road map is indicated on the picture on the display 33.

When there are stored the house map data of a region inclusive of coordinates of a specified point, coordinates of the present position or coordinates of the center of the cursor, the CPU 2 reads the house map data of this region from the data storage unit 37 and indicates them on the display 33 (step 92). Colors of buildings on the house map have been classified depending upon the kinds of facilities above ground. For instance, roads and vacant lots are indicated by white, buildings of individuals and companies are indicated by grey, and public facilities are indicated by orange. In the present invention, however, there is no limitation on the basis for sorting by colors or on the colors that are indicated.

When a particular place is designated by the selection of items on the list, the coordinate data in the destination data for this particular designated place are read out. Then, the house map is so indicated that the point determined by the coordinate data is located at the center of the picture on the display 33. In the case of the step 80, the house map is so displayed with the present position of the car (vehicle) at the center of the picture on the display 33.

When the house map is indicated on the display 33 (step 92), the cursor KL is indicated at the center of the picture on the display 33. The cursor KL is moved by the user. Therefore, the coordinates on the house map pinpointed by the indication point of the cursor KL are found by calculation (step 96). The place inclusive of coordinates pinpointed by the cursor KL is searched from the house shape data file (step 98).

Fig. 10 is a diagram illustrating that the coordinates (Xc, Yc) of the center KLC of the cursor KL is lying within the house shape HS. A range of coordinates of the house map picture indicated on the display 33 is operated. The house shape data included in the house map indicated on the display 33 are successively read out from the house shape data file. Furthermore, the coordinates of the center KLC of the cursor are found from the position of the center KLC of the cursor indicated on the screen. The house shape data including the coordinates of the center KLC of the cursor are searched by using the shape data included in the house shape data that are read out.

In the case of, for example, Fig. 10, a maximum value and a minimum value of X-coordinates and a maximum value and a minimum value of Y-coordinates

are found from the shape data (X0, Y0) to (X5, Y5). It is then determined whether the X-coordinate (Xc) at the center KLC of the cursor is a value lying between the maximum value and the minimum value of the X-coordinate of the shape data. This discrimination is accomplished by the comparison of the X-coordinate (Xc) of the center KLC of the cursor with the maximum X-coordinate and minimum X-coordinate. It is similarly determined whether the Y-coordinate (Yc) at the center KLC of the cursor is a value lying between a maximum value and a minimum value of the Y-coordinate of the shape data.

Here, the following calculation is carried out when the coordinate of the center KLC of the cursor lies between the maximum X-coordinate and the minimum X-coordinate and between the maximum Y-coordinate and the minimum Y-coordinate of the house shape HS. That is, the gradient of a straight line is found connecting the coordinates of the center KLC of the cursor to the vertex coordinates of the house shape HS. The thus found gradient of the straight line is compared with the gradients of straight lines surrounding the circumference of the house shape HS. Depending upon the comparison of the gradient of the straight line, it is determined whether the center KLC of the cursor lies within a plane sectionalized by the house shape HS.

As shown in Fig. 10, for example, there are found a gradient a1 of a straight line Lc connecting the center KLC of the cursor to the coordinates (X2, Y2), a gradient a2 of a straight line L2 connecting a vertex (X1, Y1) to a vertex (X2, Y2), and a gradient a3 of a straight line L3 connecting the vertex (X2, Y2) to a vertex (X3, Y3). The gradients a1, a2 and a3 are compared with each other. In the case of Fig. 10, it will be learned that the center KLC of cursor exists between the straight lines L2 and L3. Other straight lines L1, L4, L5 and L6 are found for their gradients. Gradients of the straight lines L1, L4, L5 and L6 are compared with the gradient of the straight line LC. Comparison of the gradients of the straight lines indicate that the center KLC of the cursor lies within a range surrounded by the straight lines L1 to L6 that are surrounding the outer circumference of the house shape HS.

The above-mentioned calculation is executed for all house shapes indicated on the picture on the display 33. As a result of calculation, there are detected house data including the center KLC of cursor. Next, it is determined whether indication of detailed data is requested or not (step 100). For example, when the user has touched the characters "DETAILED DATA" indicated on the display 33, it is so determined that indication of the detailed data is requested. When it is requested to indicate the detailed data, the list picture data included in the house shape data searched at the step 98 are read out from the data storage unit 37 and are sent to the image processor 9 (step 102). Then, the contents of detailed data related to a place at the center of the cursor are indicated on the display 33 in the form of a list.

Referring to Fig. 11, for example, the center of the cursor KL exists in the planar shape of the house shape HS. At this moment, when it is requested to indicate the detailed data, the detailed data related to the house shape HS pinpointed by the cursor KL are indicated on the display 33. When the house shape HS is, for example, a building housing a plurality of shops and companies, a list is indicated on the display 33 showing names of shops or companies in each of the rooms, telephone numbers, and kinds of shops or companies. When the user is looking for, for example, a bookstore and when this bookstore is located on the second floor of the building, he may confirm the bookstore on the list. When the user manipulates nothing for a predetermined period of time, it is determined that indication of the detailed data is not requested. In this case, the processing at the step 102 is not executed, and no list is indicated.

Next, it is determined whether ending the processing is requested (step 104). It is determined whether, for example, the character "RETURN" indicated on the display 33 is touched by the user or not. When the user has touched the character "RETURN", it is so determined that ending the processing is requested. In this case, the destination designation processing of Fig. 9 (steps 76, 80) ends, and the next route search processing (step 52 of Fig. 7) is executed. When ending the processing is not requested, it is then determined whether the destination is registered or not (step 106). For example, the character "REGISTER" is indicated on the picture on the display 33. Whether the user has touched this indication or not is determined by using a signal output from the touch switch 34. When the destination is registered, the house shape data searched at the step 98 are stored, as registered destination data TP, in the RAM 4 (step 108).

When the destination has not been registered, it is determined whether the user has moved the cursor KL or not. Whether the cursor KL is moved or not is determined by using an interrupt signal generated by the operation for moving the cursor KL. A picture scroll processing which is not shown is executed upon the generation of the interrupt signal. As a result, the map picture indicated on the display 33 is scrolled. The map picture indicated on the display 33 is so scrolled that the center KLC of the cursor is at the center of the picture at all times. When the scroll is discontinued, the program returns back to the step 90, the coordinates of the center KLC of the cursor are found (step 96), and the house shape data including the center KLC of the cursor are searched (step 98).

When it is requested to indicate the detailed data, a list of detailed data is indicated (steps 100, 102). When the house map data are not sufficient, the house map data being indicated on the display 33 as a result of scrolling the picture, i.e., when the range of coordinates indicated on the display 33 extends beyond the coordinates at the ends of the house map data, the result of discrimination becomes NO at the step 90. In this case the display 33 indicates a road map with the coordinates

of the center KLC of the cursor at the center of the picture instead of indicating the house map (step 93).

At the time of starting the destination designation processing of Fig. 9, when it is determined that the house map data contain none of the coordinates of the above-mentioned particular place, coordinates of the present position or coordinates of the center of the cursor (step 90), then, the road map data are read out and are indicated on the display 33 (step 93). The road map is so indicated that the coordinates of the above-mentioned particular place, coordinates of the present position or coordinates of the center of the cursor are at the center of the picture on the display 33.

As the road map is indicated on the display 33 (step 93), the cursor KL is indicated at the center of the picture on the display 33 and geographical coordinates of the center of the cursor KL are found by the CPU 2 (step 94).

Next, it is determined whether the ending the destination designation processing of Fig. 9 is requested or not (step 104). It is determined whether the character "RETURN" indicated on the display 33 is touched by the user or not. When the character "RETURN" is touched by the user, it is determined that ending the processing is requested. When the ending is requested, therefore, the destination designation processing (steps 76, 80) ends and the next route search processing (step 52) is executed. When the ending is not requested, it is, then, determined whether the destination is registered or not (step 106). When the destination is registered, a point that is pinpointed by the center KLC of the cursor searched at the step 94 is registered, as registered destination data TP, in the RAM 4 (step 108).

When the destination is not registered and the user moves the cursor KL to change the position for designating the destination, the picture is scrolled. That is, the picture of the road map indicated on the display 33 is scrolled. The map picture indicated on the display 33 is so scrolled that the center KLC of the cursor is at the center of the picture at all times. When the scrolling is discontinued, the program returns back to the step 90 to find the coordinates of the center KLC of the cursor (step 93).

When the house map is indicated such that the center KLC of the cursor is at the center of the picture within the coordinate range indicated on the display 33 due to the scrolling of the picture, the result determined at the step 90 becomes YES. In this case, the house map with the coordinates of center KLC of the cursor at the center of the picture is indicated instead of the road map (step 92).

When the destination is selected from the list of places (points) as described above, the house map including coordinates of the selected place is automatically indicated on the display 33 (steps 76, 90, 92). When the user requests the indication of the house map, furthermore, the house map including the coordinates of the present position is indicated on the display 33 (steps 80, 90, 92). Then, the coordinates of the center KLC of the cursor are found (step 96) and the house shape data including the center KLC of the cursor within the range of the house shape are searched (step 98).

When the house map is indicated on the display 33, therefore, the center KLC of the cursor that is brought within the range of the house shape makes it possible to designate the place of the house shape as the destination. Thus, the destination is easily designated. In this embodiment, in other words, the cursor is not brought to the coordinates of a point but is brought within a plane surrounded by the house shape to automatically designate the destination. Therefore, there is no need to move the cursor precisely to the destination on the map indicated on the picture. That is, if the cursor is moved to a given position within a plane figure indicated as the house shape, the destination is designated; i.e., the destination is designated easier than any other conventional navigation devices.

The house shape data further contains detailed data together with the shape data. When a place is designated by the user, therefore, data related to concrete equipment in the facility at that place can be indicated on the display 33. In setting the destination, therefore, it is able to make sure detailed contents of the facility at the destination. When the car is running at a speed faster than a predetermined speed, furthermore, the operation for designating the destination is inhibited (step 60 in Fig. 8). That is, the operation for designating the destination is able only when the car is halting or is running at a speed slower than the predetermined speed.

When the house map cannot be indicated on the whole picture of the display 33 despite it is requested to indicate the house map (step 78), the road map is indicated, instead. That is, the road map is indicated when the house map data for indicating the house map over the whole picture of the display 33 have not been stored in the data storage unit 37. Thus, the map indicated on the display 33 is changed over from the house map into the road map in the following cases. That is, the data storage unit 37 is not storing the house map data in amounts enough for indicating the house map with the present position of the car at the center of the display 33. Furthermore, when the house map is indicated on the display 33, the indicated picture is scrolled accompanying the motion of the cursor KL, and the geographical range of the indicated picture is deviated out of the coordinate range of the house map that can be displayed. Therefore, the map is indicated on the picture on the display 33 at all times.

8. Second Embodiment.

The following embodiment is concerned with a navigation device which stores the road map formed based upon the road data and the house map formed based upon the data related to buildings such as shapes of buildings (road data file) and changes over the map as

required (map change-over processing of Fig. 14, steps 190, 191, 193, 195 and 197 in Fig. 13, and steps 362, 363, 365, 375 and 377 in Fig. 18).

The embodiment mentioned below comprises a data storage means (road data file) for storing map data, a present position detection means (step 50 in Fig. 7) for detecting the present position of the car, an input means (destination designation processing in Fig. 8) for inputting data such as destination and the like necessary for calculating the route, a route operation means (step 52 in Fig. 7) for operating the route based upon the data input from the input means and the map data stored in the data storage means, a route guide means (step 53 in Fig. 7) for guiding the route based upon the route operated by the route operation means and the present position detected by the present position detection means, an indication means (display 33) for indicating the map data read from the data storage means and for indicating a route operated by the route operation means, and a map data change-over means (map change-over processing of Fig. 14, steps 190, 191, 193, 195 and 197 of Fig. 13, and steps 362, 363, 365, 375 and 377 of Fig. 18) for changing over the map data that are to be indicated on the indication means, wherein the data storage means includes a road map data storage means (road map data file) for storing road map data formed based upon the road data and a house map data storage means (house map data file) for storing house map data formed based upon the data related to buildings such as shapes of buildings, and wherein, upon discriminating predetermined conditions, the map data change-over means changes over the map data formed by reading the road map data from the road map data storage means and the map data formed by reading the house map data from the house map data storage means, and outputs them to the indicator means.

9. Overall Circuitry.

The overall circuitry according to the second embodiment is the same as the overall circuitry of the first embodiment shown in Fig. 1, and is not described here.

10. Data Groups.

Fig. 12 illustrates some of the data groups stored in the RAM 4. Onto the external data GD are copied whole or part of the data stored in the data storage unit 37. The present position data MP are the present position data of the car detected by the present position detector 20. The absolute direction data ZD are data representing the south-north direction found based upon the data from the absolute direction sensor 21. The relative direction angle data represent an angle subtended by a travelling direction of the vehicle found based upon the data from the relative direction sensor 22 with respect to the absolute direction. The travelled distance data ML represent a distance travelled by the vehicle found based upon the data from the distance sensor 23.

The present position data PI are data related to the present position input through the beacon receiver unit 26 or the data transmitter/receiver unit 27. The VICS data VD and the ATIS data AD are the data of VICS or ATIS input through the beacon receiver unit 26 or the data transmitter/receiver unit 27. The registered destination data TP are data related to the position or name of a destination registered by the user. The guide route data MW are the data representing the best route or a recommended route up to the destination searched through a route search processing (step 52) that will be described later.

The running speed data MV represent the running speed of the car detected by the speed sensor 24. Start-point-of-route data SP are coordinate data on a map of a point from where the navigation operation starts, the start point being determined by the route search processing (step 52). The end-point-of-route data EP are coordinate data on a map of a point at where the navigation operation ends, the end point being determined by the route search processing (step 52). A house map indication flag JF represents the request for indicating the house map on the display 33. A reduced scale data SD represent a reduced scale of the road map indicated on the display 33.

A road map indication flag DF represents the request for indicating the road map on the display 33. destination distance data MD represent a distance from the present position up to a registered destination TP. A manual indication flag MF represents the request for indicating the house map on the display 33 relying upon the manual operation by the user. A house map being-indicated flag HF represents that the house map is being indicated on the display 33 or not. The RAM 4 is equipped with registers for storing recommended drop-in place data DK, drop-in place data DP, range-of-search data SA, search condition data KJ, and a drop-in place setting flag TF. The recommended drop-in place data DK are related to places designated by the user where he many drop in on the way of the guide route through up to the destination.

11. House Shape Data.

The house shape data according to the second embodiment are the same as the house shape data of the first embodiment shown in Fig. 5, and are not described here.

12. Overall Processing.

The overall processing according to the second embodiment is nearly the same as the overall processing of the first embodiment shown in Fig. 7.

The present position-obtaining processing (step 50) of Fig. 7 obtains the present position of the vehicle based upon the data sent from the present position detector 20. In the present position operation process-

ing, the longitude and latitude are found from the data input through the GPS receiver unit 25. The longitude and latitude are stored in the RAM 4 as the present position data MP. The present position data MP may be corrected by data related to the present position input from the beacon receiver unit 26 or the data transmitter/receiver unit 27.

The operation for specifying the position of the car is executed based upon the absolute direction data ZD, relative direction angle data , and travelled distance data ML. The position of the car calculated through this operation is collated with the positions of roads in the map data written onto the external data GD. When the map is indicated on the picture on the display 33, the present position of the car is properly corrected and is indicated. This processing makes it possible to correctly find the present position of the car even when the GPS signals cannot be received because the user is running through tunnels or due to any other reason.

In the destination-setting processing (step 51 of Fig. 7, and Fig. 8), the destination is specified through the manipulation by the user. When the user selects, for example, a destination-setting mode, a road map with the present position at the center is indicated on the display 33. As the road map is indicated, characters "LIST INPUT" and "HOUSE MAP INPUT" are also indicated on the picture on the display 33. When the user touches the characters "LIST INPUT" on the picture, it is so determined that the list input mode is selected.
When the list input mode is selected, a menu is indicated on the picture on the display 33 containing items to be searched, such as address, telephone number, genre, name, etc. When the user selects some items in the menu, destinations that meet the selected items are selected. When required data are input after the items of the menu have been selected, a destination is finally selected. As required, detailed guide of the destinations can be indicated.

In the house map input mode, the house map in the vicinity of the present position is indicated on the display 33. Then, any point indicated on the picture on the display 33 is designated by the cursor to thereby specify a destination desired by the user. In this case, the cursor is so moved that the center of the cursor lies within a range of the house shape which is a desired destination.

In the list input mode or in the house map input mode, when the operation for designating the destination is finished, the user further executes the operation for confirming the destination. Then, the data related to the confirmed destination are stored, as registered destination data TP, in the RAM 4. The destination-setting processing (step 51) is jumped over when no destination is newly set.

When the house map is indicated in the destination-setting processing (step 51), furthermore, indication is changed over from the house map to the road map depending upon the predetermined conditions. The change-over of the map is executed either by manual operation by the user or automatically. For example, when the car is running at a speed faster than a predetermined speed, the road map is indicated on the display 33. When the car is halting or is running at a speed slower than the predetermined speed, the house map is indicated on the display 33. Furthermore, when the house map being indicated is scrolled so as to be deviated out of the range of coordinates in which the destination or the present position is contained, the indication is changed over to the road map.

The route search processing (step 52) searches the guide route up to the destination by using the registered destination data TP, present position data MP and road data. The road number data of roads constituting the guide route are arranged in the order of roads from the start point to the destination. The thus arranged road number data are stored, as guide route data MW, in the RAM 4. When the user wishes to travel from, for example, a start point to a destination, the user designates the destination in the destination-setting processing (step 51). The destination that is designated is a registered destination. This destination or a point on the road that is guided and is close to this destination, is regarded to be an end point of route EP.

The present position of the vehicle becomes a start point. The present position or a point on a road that is guided and is close to the present position, is a start point of route SP. The road that is most suited or recommended for connecting the start point of route SP to the end point of route EP is searched automatically. The guide route is constituted by selecting roads out of the roads connecting the two intersections or branching points to successively connect the start point of route SP to the end point of route EP. The conditions for selecting the roads that constitute the guide route are the following three. First, the guide route that is constituted is the shortest. Second, principal roads are much included. Third, the car is able to travel up to the end point of route EP quickly and smoothly. The road number data of the roads constituting the guide route are stored, as guide route data MW, in the RAM 4. The guide route search processing is equal to the processing for operating the road numbers constituting the guide route based on a predetermined processing by using road data.

In the next guidance indication processing (step 53), the route search processing (step 52) is executed either in response to a predetermined switch operation or voice or automatically in case the present position has deviated from the guide route, and the guide route is set again. The route search processing (step 52) is jumped over when there is no change in the guide route.

In the guidance indication processing (step 53), the guide route found by the route search processing (step 52) is indicated by a thick line of a conspicuous color such as red, blue, etc. on the picture on the display 33. Moreover, a present position mark representing the present position and a destination direction mark representing the direction of the destination relative to the

present position, are indicated. Guidance information by voice is produced from a speaker 13, or guide information is indicated on the map picture, so that the user is able drive his car along the guide route. The map for indicating the guide route utilizes a road map which includes geographical data such as roads in the vicinities of the present position, facilities, etc. and a house map in the vicinities of the present position. Instead of the road map, there may be used a simplified guide route picture without indicating geographical data but indicating only a minimum of data such as guide route, direction of destination, present position, etc.

When the car has approached a guide point such as an intersection that has been determined in advance, furthermore, a map near the guide point is indicated on an enlarged scale. As the map of an enlarged scale is indicated, furthermore, guide information is indicated accompanied by the sounding of guide information by voice. The present position is corrected as the car proceeds, and the map picture is automatically scrolled accompanying the movement of the present position. In the guide indication processing (step 53), furthermore, the picture that is indicated is changed over from the road map or from a simple guide route picture into a house map, or from a house map into a road map or into a simple guide route picture. The map is changed over in response to the manual operation by the user or automatically.

When the running speed of the car is faster than a predetermined speed, either a road map of a simple guide route picture is indicated. When the running speed of the car becomes lower than the predetermined speed or the car comes into a halt, the road map or the simple guide route picture can be changed over to the house map. When the coordinates of the present position are deviated out of the coordinate range covered by the house map that is being indicated, the map being indicated is changed over to the road map or to the simple guide route picture in the vicinities of the present position. When the car has approached within a predetermined distance from the registered destination, the map being indicated may be automatically changed over to the house map from the road map or from the simple guide route picture.

13. Destination-Setting Processing.

The destination-setting processing according to the second embodiment is the same as the destination-setting processing (step 51) of the first embodiment shown in Fig. 8. It is first determined whether the car is halting or not (step 60). Concretely speaking, the running speed data MV are read out from the RAM 4 and it is determined whether the running speed of the car is 0 kg/h or slower than a predetermined speed. When it is determined that the car is not halting, the destination-setting processing (step 51) ends, and the next route search processing (step 52) is executed.

On the other hand, when it is determined at the step 60 that the car is halting, it is determined whether a list input mode is being selected by the user or not (step 62). When the list input mode is selected, a destination is set from the list of items for searching the destination. When, for example, the destination-setting processing (step 51) is started, the road map in the vicinities of the present position is indicated on the display 33. Moreover, characters "LIST INPUT" are indicated. When the user touches this indication, a touch signal is output from the touch switch 34. When the touch signal is detected, a list input flag is set.

At the step 62, it is determined whether the list input flag has been set or not. In the case of the list input mode, a menu for searching the destination, such as "address", "telephone number", "genre", etc. is indicated. When the user touches a character of a desired item, a touch signal corresponding to the indication is output from the touch switch 34. The flag of a corresponding item such as address flag, telephone number flag, genre flag or the like flag, is set in response to the touch signal.

At the steps 64 to 68, it is determined which flags are being bet. A character "RETURN" is also indicated on the menu picture. When the character "RETURN" is touched, the destination-setting processing (step 51) ends, and the road map of before the menu picture is indicated is indicated on the display 33. The item of list input is not limited to the one mentioned above but may be the "name" of a company or a facility or the "name of an individual person".

When any item is selected by the user out of the menu picture, a picture for input corresponding to the selected item is indicated on the display 33 (step 74). The picture for data input is indicated based upon the destination data file and the detailed destination data file. When, for example, an item "ADDRESS" is selected, the names of metropolis and districts are first, indicated on a list. Then, a list of the names of cities, towns and villages is indicated on the picture. Thereafter, a picture is indicated for inputting the name of a street number, etc.

The address is input by selecting a first letter of the address out of alphabets or by selecting the name in the order of metropolis and districts. The address is input by the user upon touching the name of metropolis and districts or numerals indicated on the picture. When an item "PHONE NUMBER" is selected, numerals 1 to 0 are indicated. When the indicated numerals are touched by the user, the touched numerals are input as a telephone number.

When an item "GENRE" is selected, a list of the names of a plurality of genres is indicated on the picture. When a desired genre indication is touched on the list indicated on the picture, the genre that is touched is selected. Then, the places corresponding to the selected genre are indicated on the display 33 being arranged in the alphabetical order or in the order of metropolis and districts. The user touches a desired name in the list indicated on the picture. The touched

name is thus selected.

As a particular place which is a destination is thus designated by using a list which is indicated successively on the picture, the thus designated destination is stored in the RAM 4 (step 76). The coordinate data of each of the places that may be designated as a destination and that have been stored in the destination data file are the coordinate data of a particular point determined for each of the places. For example, the center coordinates of a site of a place are regarded as coordinate data.

When indication of the house map is requested at a moment when the destination-setting processing (step 51) is started (step 78 is YES), the destination is designated by utilizing the house map that is indicated (step 80). The processing at the step 80 is the same as that of the step 76. The switch for setting the destination may be an operation switch provided neighboring the picture or the cursor indicated on the display 33 in addition to the touch switch 34.

14. Destination Designation Processing.

Fig. 13 is a flow chart illustrating the destination designation processing at the steps 76 and 80. In this processing, the house map is indicated on the display 33 when the house map data that can be indicated have been stored in the data storage unit 37. Then, a place designated by using the cursor is searched based upon the house shape data. The place that is searched is stored, as the registered destination TP, in the RAM 4. When requested by the user, furthermore, detailed data of a place designated by using the cursor are indicated on the display 33.

It is, first, determined whether the house map for designating the destination has been recorded or not (step 190). In the case of the step 76, it is determined whether there are house map data including coordinates of a particular place selected at the step 74. In the case of the step 80, it is determined whether there are house map data including coordinates of the present position. When the picture is scrolled, furthermore, it is determined whether there are house map data inclusive of coordinates of the center of the cursor. It is presumed that the house map data stored in the data storage unit 37 are, for example, map data defining a square range. It is then determined whether the coordinates of the above-mentioned particular place, coordinates of the present position or coordinates of the center of the cursor exist within a range surrounded by the coordinates of four vertexes of the house map data. When these coordinates lie within a square range of the house map data, it means that the house map that can be indicated has been stored in the data storage unit 37.

When there are house map data that include coordinates of the above-mentioned particular place, coordinates of the present position or coordinates of the center of the cursor, it is, then, determined whether the road map has been indicated on the display 33 or not (step 191). Here, it is determined whether the house map being-indicated flag HF is off or not. When the road map is indicated, the reduced scale of the road map that is indicated is stored in the RAM 4 (step 192). When the house map is not indicated on the display 33, on the other hand, the processing at the step 192 is not executed. The CPU 2 then reads the house map data in the vicinity of the present position from the house map data file. The house map data that are read out are sent to the image processor 9. Then, the display 33 indicates the house map with the present position at the center of the picture (step 193). When the house map is indicated on the display 33, as described above, the house map being-indicated flag HF is turned on.

Colors of buildings on the house map are, for example, such that roads and vacant lots are indicated by white, buildings of individuals and companies are indicated by grey, and public facilities are indicated by orange. That is, colors of buildings are classified depending upon the attribute of buildings at the places. There is, as a matter of course, no limitation on the basis for sorting by colors or on the colors that are indicated. When a particular place is designated by successively selecting the items on the list indicated on the picture, the coordinate data in the destination data for this particular designated place are read out. Then, the house map is so indicated that the point determined by the coordinate data is located at the center of the picture on the display 33.

When the house map is indicated on the display 33 (step 193), the cursor KL is indicated at the center of the picture on the display 33. Furthermore, the coordinates of the center of the cursor KL is found by the CPU 2 (step 194). The place inclusive of coordinates of the center of the cursor KL is searched from the house shape data file (step 199).

For instance, the coordinates of the center KLC of the cursor are found by operating the center of the coordinate range of the picture indicated on the display 33. The house shape data included in the house map indicated on the display 33 are successively read out from the house shape data file. The house shape data including the coordinates of the center KLC of the cursor are searched by using the shape data included in the house shape data that are read out.

For example, maximum X-coordinates and Y-coordinates, as well as minimum X-coordinates and minimum Y-coordinates can be found from the shape data (X0, Y0) to (X5, Y5) of the house shape HS shown in Fig. 6. It is then determined whether the X-coordinate (Xc) at the center KLC of the cursor is a value lying between the maximum X-coordinate and the minimum X-coordinate. This discrimination is accomplished by the comparison of the X-coordinate (Xc) of the center KLC of the cursor with the maximum X-coordinate and minimum X-coordinate.

It is similarly determined whether the Y-coordinate (Yc) at the center KLC of the cursor is a value lying between a maximum Y-coordinate and a minimum Y-

coordinate. Here, when the coordinate of the center KLC of the cursor lies between the maximum values and minimum values of X-coordinates and Y-coordinates in the house shape HS, the gradient of a straight line is found connecting the coordinates of the center KLC of the cursor to the coordinates of the house shape HS. The thus calculated gradient is compared with the gradients of straight lines surrounding the circumference of the house shape HS. Depending upon the comparison of the gradient of the straight line, it is determined whether the center KLC of the cursor lies within the range of a planar house shape HS or not.

For example, there are calculated a gradient a1 of a straight line Lc connecting the center KLC of the cursor to the coordinates (X2, Y2), a gradient a2 of a straight line L2 connecting the coordinates (X1, Y1) to the coordinates (X2, Y2), and a gradient a3 of a straight line L3 connecting the coordinates (X2, Y2) to the coordinates (X3, Y3). The gradients of the straight lines LC, L2 and L3 are compared with each other to discriminate whether the center KLC of the cursor exists between the straight lines L2 and L3. The same operation is executed even for other straight lines L1, L4, L5 and L6. Comparison of the gradients of the straight lines indicate whether the center KLC of the cursor lies within a range surrounded by the straight lines L1 to L6 that are surrounding the outer circumference of the house shape HS.

As the house shape data including the coordinates of the center KLC of the cursor are searched as described above, it is then determined whether indication of detailed data is requested or not (step 200). This discrimination is executed based upon whether the characters "DETAILED DATA" indicated on the display 33 are touched by the user or not. When the indication of detailed data is requested, the list picture data included in the house shape data searched at the step 99 are read out and are sent to the image processor 9 (step 202). Then, the display 33 indicates, in the form of a list, the contents of the detailed data related to the place at the center of the cursor.

When the house shape HS is, for example, a building housing a plurality of shops and companies, a list is indicated showing names of shops or companies, telephone numbers, and kinds of shops or companies in each of the rooms. When the user is looking for, for example, a bookstore and when this bookstore is located on the second floor of the building, he will easily find out the bookstore on the list. When the indication of detailed contents is not requested by the user for a predetermined period of time, on the other hand, the processing at the step 202 is not executed. That is, the list of "DETAILED DATA" is not indicated.

Next, it is determined whether a command is input to end the processing (step 204). Concretely, it is determined whether, for example, the character "RETURN" indicated on the display 33 is touched by the user or not. When ending the processing is requested, the destination designation processing (steps 76, 80) ends, and the next route search processing (step 52) is executed.

When ending the processing is not requested, it is then determined whether the destination is registered or not (step 206). For example, the character "REGISTER" is indicated on the picture on the display 33. Whether the user has touched the indicated character "REGISTER" or not is determined by using a signal output from the touch switch 34. When the destination is registered, the house shape data searched at the step 199 are stored, as registered destination data TP, in the RAM 4 (step 208).

When the destination has not been registered, it is determined whether the user has moved the cursor KL or not. When the cursor KL is moved, it is so determined that the destination is changed. As the cursor KL is moved, the picture is scrolled. The map picture indicated on the display 33 is scrolled. The map picture indicated on the display 33 is so scrolled that the center KLC of the cursor is at the center of the picture at all times. When the scrolling is discontinued, the program returns back to the step 190, and the coordinates of the center KLC of the cursor are found (step 194). Then, the house shape data including the center KLC of the cursor are searched (step 199). When it is requested to indicate the detailed data, a list of detailed data is indicated (steps 200, 202).

When the range of the house map indicated on the display 33 has run out accompanying the scrolling of the picture, the map indicated on the display 33 is changed over from the house map to the road map. That is, when the range of coordinates indicated on the display 33 deviates out of the coordinates at the edges of the house map data, the result of discrimination at the step 190 becomes NO. When the result of discrimination at the step 190 is NO, the map indicated on the display 33 is changed over to the road map with the coordinates of the center KLC of the cursor at the center of the picture (step 197).

On the other hand, when it is determined at the step 190 that the data storage unit 37 is not storing the house map data that include coordinates of the above-mentioned particular place, coordinates of the present position or coordinates of the center of the cursor, the processing of the step 195 is executed. At the step 195, it is determined whether the house map is being indicated on the display 33 or not. This is determined depending upon whether the house map being-indicated flag HF is on or not. Here, when the road map has been indicated already, there is no need to change the map indication mode, and no processing is executed at the next step 196. On the other hand, when the house map is being indicated, the indication mode on the display 33 is changed over to a mode for indicating the road map. In this case, the reduced scale data SD stored in the RAM 4 are read out, the reduced scale data SD having been stored at the time when the road map indication mode was changed over to the house map indication mode (step 196).

Then, in the road map in the vicinity of the present

position, the road map data of a reduced scale that meet the above-mentioned reduced scale data SD are read out from the road map data file and are sent to the image processor 9. Then, the display 33 indicates the road map having coordinates of the above-mentioned particular place, present position or center of the cursor at the center of the picture (step 197). Since the road map is indicated on the display 33, the house map being-indicated flag HF is reset to be turned off. As the road map is indicated on the display 33, the cursor KL is indicated at the center of the picture on the display 33. Then, the geographical coordinates of the center KLC of the cursor are found (step 198).

It is then determined whether a command is input to end the destination designation processing of Fig. 13 or not (step 204). Concretely speaking, it is determined whether the character "RETURN" indicated on the display 33 is touched by the user or not. When ending the processing is requested, the destination designation processing of Fig. 13 ends, and the next route search processing (step 52 of Fig. 7) is executed.

When there is no request for ending the processing, it is then determined whether the operation is executed to register the destination (step 206). For instance, the character "REGISTER" is indicated on the picture on the display 33. Whether the indicated character "REGISTER" is touched by the user or not is determined by utilizing the output signal of the touch switch 34. When the operation for registration is executed, the house shape data searched at the step 199 are stored, as registered destination data TP, in the RAM 4 (step 208).

When the operation for registration is not executed, it is determined whether the user has moved the cursor KL or not. When the cursor KL is moved, it is so determined that the destination is changed. Upon moving the cursor KL, the picture is scrolled. Then, the map picture indicated on the display 33 is scrolled. The map picture indicated on the display 33 is so scrolled that the center KLC of the cursor is at the center of the picture at all times. When the scrolling is discontinued, the program returns back to the step 190 where the coordinates of the center KLC of the cursor are found (step 198).

When the house map is indicated within the coordinate range indicated on the display 33 with the center KLC of the cursor at the center of the picture as a result of scrolling the picture, the result of discrimination at the step 190 becomes YES. As a result, the display 33 indicates the house map with the coordinates of the center KLC of the cursor at the center of the picture (step 193).

15. Map Change-Over Processing.

Fig. 14 is a flow chart of a map change-over processing (step 210) executed in the guide indication processing (step 53). This map change-over processing executes a manual operation processing (step 220), a destination approach change-over processing (step 222), a house map change-over processing (step 224), and other processings. In the manual operation processing (step 220), the mode for indicating the house map and the mode for indicating the road map are changed over depending upon the manual operation by the user.

In the destination approach change-over processing (step 222), the mode for indicating the road map is changed over to the mode for indicating the house map when a straight distance between the car that is moving and the registered destination becomes smaller than a predetermined distance. In the house map change-over processing (step 224), indication of the house map is permitted when the running speed of the car becomes slower than a predetermined speed or when the car comes into a halt. Conversely, indication of the house map is inhibited when the running speed of the car exceeds the predetermined speed.

The road map is indicated even when the house map in the vicinity of the present position indicated on the picture on the display 33 is no longer stored in the data storage unit 37. In other processings, the mode for indicating the house map and the mode for indicating the road map are changed over depending upon other change-over conditions.

16. Processing for Manual Operation.

Fig. 15 is a flow chart illustrating the manual operation processing (step 220) of Fig. 14. It is, first, determined whether it is attempted to change over the indication mode on the picture (step 230). In other words, it is determined whether the user has requested to change over the indication mode or not. In requesting the indication mode to be changed over, it is further determined whether indication of the house map is requested or indication of the road map is requested (steps 232, 242).

When indication of the house map is requested, it is then determined whether the picture indicated on the display 33 is a house map or not (step 234). This is determined relying upon whether the house map being-indicated flag HF is on or not. The house map being-indicated flag HF is set to be on when the house map is being indicated on the display 33 and is reset to be off when the road map is being indicated. The house map being-indicated flag HF is reset to be off in the initialization processing.

When the house map has been indicated already, there is no need to change over the map indication mode and the manual operation processing (step 220) ends. When the road map is being indicated, the house map indication flag JF is set to be on (step 236) and the road map indication flag DF is reset to be off (step 238). The house map indication flag JF is set to be on when the house map is indicated on the display 33 and is reset to be off when the road map is indicated. The road map indication flag DF is set to be on when the road map is indicated on the display 33 and is reset to be off when the house map is indicated. In the initialization processing, the house map indication flag JF is reset to

be off and the road map indication flag DF is set to be on.

When the house map indication flag JF is set to be on, it is determined in the house map change-over processing (step 224) that will be described later whether the house map can be indicated on the display 33 or not. Then, a manual indication flag MF is set to be on (step 240). The manual indication flag MF is the one for storing the fact that indication of the house map has been requested by manual operation. When it is requested to indicate the road map by manual operation, on the other hand, the manual indication flag MF is reset to be off (step 250).

When the road map indication mode is requested (step 242) by the indication mode switching operation by the user, it is determined whether the picture indicated on the display 33 is a road map or not (step 244). This is determined depending upon whether the house map being-indicated flag HF is off or not. When the road map has been indicated already, there is no need to change over the map indication mode. Then, the manual operation processing (step 220) of Fig. 15 ends. When the house map is indicated, on the other hand, the road map indication flag DF is set to be on (step 246) and the house map indication flag JF is reset to be off (step 248). When the road map indication flag DF is set to be on, the road map is indicated on the display 33 depending upon discrimination of conditions executed by the house map change-over processing (step 224) that will be described later. The manual indication flag MF is then reset to be off (step 250).

17. Destination Approach Change-Over Processing.

Fig. 16 is a flow chart of the destination approach change-over processing (step 222) of Fig. 14. Tn this processing, the house map is indicated on the display 33 when the distance between the present position of the car and the registered destination becomes within a predetermined value. Besides, the route up to the registered destination is guided using this house map. When the distance between the present position and the registered destination is larger than the predetermined value, the road map is indicated on the display 33.

First, the present position data MP and the registered destination data TP are read out from the RAM 4 (steps 260, 262). A difference is found between the coordinate value of the present position of the car and the coordinate value of the registered destination. A straight distance from the present position to the registered destination is found depending upon a difference in the coordinate values. The thus found distance is stored, as destination distance data MD, in the RAM 4 (step 264). When the car is running, therefore, the destination distance data MD is updated at all times. A remaining distance of when the car runs from the present position MP to the end point of route EP along the route MW, may be used as the destination distance data MD instead of the above-mentioned straight distance.

Next, it is determined whether the distance from the present position of the car to the registered destination is approaching the predetermined distance or not (step 268). For example, it is determined whether the destination distance MD is smaller than a reference distance SL. The reference distance SL is also used for judging whether the processing for guiding the route using the house map be started or not. The reference distance SL has been stored in advance in the flash memory 3.

Here, when MD ≦ SL, it means that the present position of the car is approaching the destination, and a processing is executed for indicating the house map on the display 33. It is, first, determined, whether the house map is being indicated on the display 33 or not (step 270). This is determined depending upon whether the house map being-indicated flag HF is on or not. When the house map is being indicated already, there is no need to change over the map indication mode and the destination approach change-over processing (step 222) ends.

When the road map is indicated, on the other hand, the house map indication flag JF is set to be on (step 272) and the road map indication flag DF is reset to be off (step 274). With the house map indication flag JF being set to be on, it is determined in the house map change-over processing (step 224) that will be mentioned later whether the house map can be indicated on the display 33 or not. In the house map change-over processing that will be described later, therefore, the house map is indicated when the conditions are satisfied.

On the other hand, when the destination distance MD is larger than the reference value SL, a processing is carried out to indicate the road map on the display 33. That is, the processing after the step 276 is started. At the step 276, it is determined whether the manual indication flag MF is off or not. When indication of the house map has been requested by the user in the above-mentioned manual operation processing (step 220), this request of the user takes precedence. When the manual indication flag MF is on, therefore, the processing after the step 278 is neglected. As a result, the house map indication mode continues.

When it is determined at the step 276 that the manual indication flag MF is off, it is, then, determined whether the picture indicated on the display 33 is a road map or not (step 278). This is determined depending upon whether the house map being-indicated flag HF is off or not. When the house map being-indicated flag HF is off, the road map has been indicated already and there is no need to change over the map indication mode. Therefore, the destination approach change-over processing (step 222) ends. When the house map is indicated, on the other hand, the road map indication flag DF is set to be on (step 280), and the house map indication flag JF is reset to be off (step 282). With the road map indication flag DF being set to be on, the road map is indicated on the display 33 in the house map

change-over processing (step 224) that will be described later only when other conditions are satisfied.

18. House Map Change-Over Processing

Fig. 17 is a flow chart of the house map change-over processing (step 224) of Fig. 14. In this processing, the house map is indicated on the display 33 when the house map indication flag JF is set to be on in the manual operation processing (step 220) and in the destination approach change-over processing (step 222). When the road map indication flag DF is set to be on, on the other hand, the road map is indicated on the display 33. The house map can be indicated when the running speed of the car becomes slower than a predetermined speed or when the car comes into a halt. Therefore, indication of the house map is inhibited when the running speed of the car is larger than the predetermined speed or when the car is running. The road map is indicated even when there is no house map in the vicinity of the present position that can be indicated on the picture of the display 33. When the data of the house map that can be indicated on the display 33 have not been stored in the data storage unit 37, the road map only is indicated on the display 33.

First, it is determined whether the house map indication flag JF is on or not (step 290). When the house map indication flag JF is on, it means that the house map can be indicated and it is further determined whether other conditions are satisfied or not. First, the running speed data MV are read out from the RAM 4 (step 292). Based upon the running speed data MV, it is determined whether the car is halting or not (step 294). The running speed data MV are updated at all times based upon the data signals from the car speed sensor 24.

Concretely speaking, it is determined whether the running speed of the car detected by the car speed sensor 24 is 0 kg/h or is slower than a predetermined speed. When it is determined that the running speed of the car is slower than the predetermined speed, the house map can be indicated. Next, it is determined whether the house map in the vicinity of the present position of the car has been stored in the data storage unit 37 or not. That is, the present position data MP are read out from the RAM 4 (step 296). It is, then, determined whether the data storage unit 37 is storing the house map data which include coordinates of the present position data MP and are capable of indicating the house map over the whole picture on the display 33 (step 298).

When it is determined that the house map can be indicated, it is then determined whether the road map is being indicated on the display 33 (step 300). This is determined depending upon whether the house map being-indicated flag HF is off or not. When it is determined that the road map is being indicated, the reduced scale of the road map being indicated is stored, as reduced scale data SD, in the RAM 4 (step 302). When the house map is indicated on the display 33, on the other hand, the step 302 is not executed.

The house map data in the vicinity of the present position are read out from the house map data file and are sent to the image processor 9. Then, the display 33 indicates the house map with the present position of the car at the center of the map (step 304). Since the house map is indicated on the display 33, the house map being-indicated flag HF is set to be on (step 306).

On the other hand, when it is determined at the step 290 that the house map indication flag JF is off, it is then determined whether the road map indication flag DF is on or not (step 308). Here, when the road map indication flag DF is on, the road map is indicated.

Despite it is requested to indicate the house map, the road map is indicated when the car is running at a speed faster than the predetermined speed (step 294 is NO) or when the data storage unit 37 is not storing the house map data for indicating the house map in the vicinity of the present position on the display 33 (step 298 is NO). When the result of discrimination at the step 308 is YES, when the result of discrimination at the step 294 is NO or when the result of discrimination at the step 298 is NO, it is then determined whether the house map is indicated on the display 33 (step 310). This is determined depending upon whether the house map being-indicated flag HF is on or not. Here, when the road map has been indicated already, there is no need to change the map indication mode. Therefore, the house map change-over processing (step 224) of Fig. 17 ends. On the other hand, when it is detected at a step 310 that the house map is indicated, the indication mode is changed over to the road map indication mode. When the road map indication mode is changed over to the house map indication mode, the reduced scale data SD stored in the RAM 4 are read out at a step 302 (step 312).

Then, the road map data in the vicinity of the present position of the vehicle are read out from the road map data file at the same reduced scale as the reduced scale data SD. The road map data that are read out are sent to the image processor 9. Then, the display 33 indicates the road map with the present position at the center of the screen (step 314). Then, the house map being-indicated flag HF is reset to be off (step 316).

According to this embodiment, as described above, when the destination is selected by the list input in the destination-setting processing (step 51), the house map of a range including the selected destination is automatically indicated on the display 33 (step 76 of Fig. 8, step 92 of Fig. 9). Therefore, the situation around the destination can be comprehended in further detail. When the car is running at a speed faster than the predetermined speed, the destination is inhibited from being set (step 60 of Fig. 8). When the car is running at a speed faster than the predetermined speed, further, indication of the house map is also inhibited while the destination is being set. Thus, the user finds it convenient to use the

navigation device.

When the range of picture with the destination, present position or the center of cursor at the center of the picture lies outside the coordinate range of the house map stored in the data storage unit 37, it is not able to indicate the house map over the whole picture on the display 33. In this case, the house map that is indicated is automatically replaced by the road map (steps 190, 197 in Fig. 13). The road map that is substituted for the house map is the map of the same region as the house map that had been indicated. Thus, indication of the map on the display 33 is not interrupted.

When the manual operation is carried out (step 220 in Fig. 14), a map desired by the user is indicated on the display 33. That is, the map picture indicated on the display 33 is changed over to either the house map or the road map as desired by the user. When the vehicle is running, for example, the data related to the guide route can be easily obtained from the road map. In setting a point such as destination, on the other hand, the house map can be indicated, and detailed data related to the points can be easily obtained from the house map. This enables the user to easily set and register a desired destination.

When the car is running at a speed faster than the predetermined speed, indication of the house map is not permitted (step 294 in Fig. 17), and the map picture indicated on the display 33 can be seen more reliably. This is because, the house map has a small reduced scale and offers considerably detailed data of house shapes. When a guide route is indicated on such a detailed house map, the map picture is quickly scrolled accompanying the running of the car. Therefore, it becomes difficult to confirm the geographical environment in the vicinity of the running position of the car from the map indicated on the display 33. When the car is running at a speed faster than the predetermined speed, therefore, indication of the house map is inhibited, and the user is furnished with map data that can be seen reliably at all times.

When the present position of the car has approached within a predetermined distance from the destination, furthermore, the map data that are indicated are automatically changed over to the house map (step 222 in Fig. 14). This enables the user to easily recognize that he is near the destination. Besides, since the house map is automatically indicated, the user is allowed to easily confirm the destination from detailed data of the point (shape of building, etc.). This prevents such an occurrence that the user is not sure where the destination is and passes over the destination though he is near the destination.

When the map data are changed over, the reduced scale of the map data (road map, etc.) of before being changed over is stored in the memory (step 302 in Fig. 17). Therefore, even when the house map is changed over again to the road map on the display 33, reduced scale of the map is not changed unnecessarily. Accordingly, the user does not have to set again the reduced scale of the map every time when the map is changed over.

The processings in the second embodiment can be combined in a variety of ways. For instance, map change-over processing by manual operation is combined with the map change-over processing when the car is running at a speed faster than the predetermined speed. Therefore, even when the map indicated on the display 33 is changed over to the house map by manual operation, the house map is indicated only when the car is running at a speed slower than the predetermined speed. That is, when the car is running at a speed faster than the predetermined speed, the operation for indicating the house map executed by the user is neglected. Therefore, the user is furnished with map indication that can be reliably seen at all times. By combining the processings together as described above, it is able to realize a navigation device having a high commercial value. When the data storage unit 37 is storing house maps of different reduced scales covering the same area, then, the house map may be indicated even when the car is running at the predetermined speed.

19. Drop-In Place Setting Processing.

When the vehicle is running along the guide route, it may be often required to process events that are necessary for the living activities. The events necessary for the living activities may include meal, shopping, filling the car with gasoline, etc. In such cases, the navigation device may be used to search if there are places desired by the user near the present position of the car. Fig. 18 is a flow chart of a processing for setting drop-in places that will be executed in the above-mentioned cases. The drop-in places stand for the places where the user may wish to drop in to process events necessary for the living activities.

The drop-in setting processing (step 350) is provided as a subroutine in the destination setting processing (step 51) and is commenced in response to the switch operation for setting a drop-in place. The drop-in place setting processing (step 350) is repetitively executed like the present position-obtaining processing (step 50), route search processing (step 52) and guide indication processing (step 53). The RAM 4 has been provided with a register for storing recommended drop-in place data DK, drop-in place data DP, search range data SA, search condition data KJ and drop-in place setting flag TF (see Fig. 12).

First, it is determined whether the car is halting or is running at a speed slower than the predetermined speed (step 352). This is the same processing as that of the step 60 of Fig. 8. When the car is running at a speed faster than the predetermined speed, the drop-in place setting processing (step 350) is not executed. When the car is halting, a picture for promoting the input of genre is indicated on the display 33 (step 354).

For example, a list of names of a plurality of genres is indicated on the display 33 like at the step 68 of Fig.

8. The user may select a genre of a place where he wishes to drop in out of the list that is indicated (step 356). Then, the display 33 indicates a picture for specifying the range of search and search conditions (step 358). The range of search may be the one defined by a predetermined distance from the present position of the vehicle or the one defined by a city, a town or a village where the vehicle is now located. The search conditions may include, for example, parking lot, business time, fees, etc. which serve as conditions for selection by the user. The data corresponding to these conditions have been stored in the detailed destination data file.

When the range of search and the search conditions are selected by the user, the drop-in places are searched based upon the conditions (step 360). Therefore, the places that meet the selected genre and input conditions within a range of search selected by the user, are searched from the destination data file and the detailed destination data file. The searched places are stored as recommended drop-in place data, in the RAM 4.

Next, it is determined whether the data storage unit 37 is storing a house map that has the present position or the center KLC of the cursor at the center of the picture (step 362). The processing at the step 362 is the same as the processing at the step 90 of Fig. 9. Therefore, if the data storage unit 37 is storing the house map data having the present position or the center KLC of the cursor at the center of the picture, then, the house map can be indicated on the display 33. Next, it is determined whether the map that is now indicated on the display 33 is a road map or not (step 363). When the road map has been indicated, the road map that is indicated is changed over to the house map. The reduced scale of the road map that is indicated is stored in the RAM 4 (step 364). When the house map has been indicated on the display 33, on the other hand, the processing of the step 364 is not executed.

Next, the house map data of a range having the present position of the vehicle or the center KLC of the cursor at the center of the picture, are read out from the data storage unit 37. The house map data that are read out are sent to the image processor 9. Then, the house map is indicated on the display 33 (step 365). When indication of the house map is commenced, the house map being-indicated flag HF is set to be on. Due to the processing at the step 360, the area of the house shape of a place which is a recommended drop-in place is indicated in blue color (step 366).

In the processing at the step 366, the recommended drop-in place data stored in the RAM 4 are read out. A house sharp data corresponding to the recommended drop-in place data are searched from house sharp data file. The searched house shape data are stored in the RAM 4. Moreover, the shape data are read out from the house shape data stored in the RAM 4. The plane range on the house map specified by the shape data is indicated in blue color on the picture on the display 33.

Fig. 19 illustrates a state where the house map is indicated on the display 33. In the case of Fig. 19, the house shape of a place corresponding to the designated genre is indicated in blue color. In Fig. 19, such places are portions hatched with broken lines. As described above, house shapes corresponding to the conditions can be discerned on the display 33. That is, house shapes indicated in a particular state can be recognized to be recommended drop-in places.

Next, coordinates of the center KLC of the cursor are searched (step 368). The house shape designated by the coordinates of the center of the cursor is searched from the house data file in the data storage unit 37 (step 370). The searched house shape data are stored in the RAM 4. Then, the shape data are read out from the searched house shape data. The coordinate range of the shape data is indicated in red color on the picture on the display 33. That is, the house shape of a place designated by the center KLC of the cursor is indicated in red color on the picture on the display 33 (step 372). In Fig. 19, this place is a portion hatched with solid lines.

The house shape of a place designated by the center KLC of the cursor may be indicated as a solid picture. The solid picture is a plane figure of solid appearance of this place. For instance, the solid picture VS shown in Fig. 19 is indicated on a portion of the picture designated by the center KLC of the cursor. The solid picture VS is a perspective figure of appearance at a place designated by the center KLC of the cursor. In Fig. 19, the solid picture VS has been indicated being deviated from the center KLC of the cursor. In practice, however, the solid picture VS is indicated at a position of house shape where the center KLC of the cursor exists.

When the house shapes are no longer designated by the center KLC of the cursor as a result of the motion of the cursor KL, the house shapes that had been indicated in red color or as solid pictures are returned back to the initial state of indication (step 374). However, when the house shape designated by the center KLC of the cursor is the one of a place corresponding to the genre selected by the user, the color indication of the house shape is returned back to blue color from red color or the like color when it is no longer designated by the cursor KLC.

Thus, the house shape data designated by the center KLC of the cursor are searched. Next, it is determined whether indication of detailed data is requested or not (step 382). This discrimination is executed by detecting, for example, whether the characters "DETAILED DATA" indicated on the display 33 are touched by the user or not. When indication of the detailed data is requested, the picture data in the list included in the house shape data searched at the step 370 are read out from the data storage unit 37. The picture in the list that is read out is sent to the image processor 9 (step 384). Thus, the contents of detailed data related to a place designated by the center of the cursor is indicated on the display 33 in the form of a list like the

processing at the step 202 of Fig. 13.

Next, it is determined whether ending the drop-in place setting processing of Fig. 18 is requested or not (step 386). It is, for example, determined whether the character "RETURN" indicated on the display 33 is touched by the user or not. When the indicated character "RETURN" is touched, it is so determined that ending the drop-in place setting processing is requested. When ending this processing is requested, the next route search processing (step 52) is executed.

When ending the processing is not requested, it is then determined whether the drop-in place registration processing is requested or not (step 390). For instance, the character "REGISTER" is indicated in the picture on the display 33. Whether the user has touched this indicated character "REGISTER" or not is determined relying upon an output signal from the touch switch 34. When the character "REGISTER" is touched, therefore, it is so determined that the drop-in place registration processing is requested. When the registration processing is requested, the house shape data searched at the step 370 are stored, as drop-in place data DP, in the RAM 4 (step 208).

When the registration processing is not requested, it is determined whether the user has moved the cursor KL indicated on the picture on the display 33 or not. When the cursor KL is moved, it is so determined that the drop-in place is changed. When the cursor KL is moved by the user, furthermore, an interrupt signal is generated. The interrupt signal commences the picture scroll processing that is not shown. Due to the picture scroll processing, the map picture indicated on the display 33 is scrolled. The map picture indicated on the display 33 is so scrolled that the center KLC of the cursor is at the center of the picture at all times.

When the scrolling is discontinued, the processings after the step 362 are commenced again. That is, the coordinates of the center KLC of the cursor are found (step 368). The house shape data designated by the center KLC of the cursor are searched (step 370). When indication of the detailed data is requested, detailed data are indicated in the form of a list (steps 382, 384). When the house map data to be indicated on the display 33 is interrupted due to scrolling of the picture, the map indicated on the display 33 is changed over from the house map to the road map. That is, in case the coordinate range indicated on the display 33 deviates out of the coordinates at the end of house map data stored in the data storage unit 37, the house map cannot be indicated over the whole picture on the display 33.

The house map recorded in the data storage unit 37 is a map of a particular region where houses are densely built up like in a major city, town or village. When the house map indicated on the picture on the display 33 is scrolled, therefore, the house map data often becomes insufficient for being indicated on the map. When the data storage unit 37 is not storing the house map data that can be indicated on the picture, the result of discrimination at the step 362 becomes NO. When the result of discrimination at the step 362 is NO, it is determined whether the house map is indicated on the display 33 or not (step 375).

This discrimination is based upon whether the house map being-indicated flag HF is on or not. Here, when the road map has been indicted already, there is no need to change over the map indication mode and the processing at the next step 376 is not executed. When the house map is indicated on the display 33, on the other hand, the house map is changed over to the road map indication mode. When the indication on the map is changed over from the house map to the road map, furthermore, the reduced scale data SD stored in the RAM 4 at the step 364 are read out (step 376).

Then, the road map data in the vicinity of the present position are read out from the road map data file at a reduced scale designated by the reduced scale data SD. The road map data that are read out are sent to the image processor 9. Thus, the display 33 indicates the road map having the present position or the center of the cursor at the center of the picture (step 377). When the road map is indicated on the display 33, the house map being-indicated flag HF is reset to be offset.

In this road map, recommended drop-in places are indicated by, for example, blue circles. This makes it possible to easily discern the recommended drop-in places on the map. When the road map is indicated on the display 33, the cursor KL is indicated at the center of the picture on the display 33. Then, coordinates of the center KLC of the cursor are found on the road map (step 378).

Thus, as the map indicated on the display 33 are changed over from the house map to the road map, the processings are successively executed from a step 386 to a step 392. The processings of these steps are the same as those of when the house map is indicated on the display 33.

When the drop-in position registration processing is not requested at the step 388, it is then determined whether the user has moved the cursor KL or not. When the cursor KL is moved, it is so determined that the drop-in place is changed. Accompanying the motion of the cursor KL, the road map indicated on the display 33 is scrolled.

When the scrolling is discontinued, the program returns back to the step 362 to find the coordinates of the center KLC of the cursor (step 378). Accompanying the scrolling, furthermore, it is determined whether the house map can be indicated again on the whole picture on the display 33 or not (step 362). That is, when it is detected on the display 33 that the house map having the center KLC of the cursor at the center of the picture has been stored in the data storage unit 37, the result of discrimination at the step 362 becomes YES. In this case, there is indicated the house map having the coordinates of the center KLC of the cursor at the center of the picture (step 365). When the drop-in place registration processing is executed at the step 390, the drop-in place setting flag TF is set to be on. The drop-in place

setting flag TF is used for discriminating whether the drop-in place has been set or not.

As the drop-in place is set as described above, a guide route from the present position up to the drop-in place is searched by the route search processing (step 52) using the road data in the data storage unit 37. In the guide indication processing (step 53), the navigation processing is executed according to the guide route up to the drop-in place. When the route search processing (step 52) and the guide indication processing (step 53) are started, it is determined whether the drop-in place setting flag TF is on or not. When the drop-in place setting flag TF is on, the guide route up to the drop-in place is searched and the navigation processing is executed. When the drop-in place setting flag TF is off, the guide route up to the destination is searched and the navigation processing is executed.

As described above, even when the drop-in place is set, the genre is selected and the house map of a range including the present position is automatically indicated on the display 33 (step 365). This makes it possible to learn in detail the state in the vicinity of the present position of the car. Furthermore, it is possible to set the destination or the drop-in place only when the car is halting or is running at a speed slower than the predetermined speed (step 352). The map house is indicated when the car is halting or is running at a speed slower than the predetermined speed. This enhances the utility of the navigation device of the present invention.

Moreover, the house map is stored in the data storage unit 37 covering particular regions only. When the house map indicated on the display 33 is scrolled, therefore, it may often be requested to indicate the map of a region for which the house map has not been stored in the data storage unit 37. In this case, the road map is indicated instead of the house map (steps 362, 377).

Therefore, even when the map indicated on the display 33 is scrolled, the indication is not interrupted. Moreover, the house shape of a place corresponding to the genre selected by the user is indicated in a characteristic color such as blue or the like color (step 366). Besides, the house shape designated by the center KLC of the cursor is indicated in a special form such as solid picture VS or the like (step 372). This makes it easy to confirm the house shape of a position designated by the cursor. Accordingly, the time required for setting the drop-in place or the destination can be shortened.

20. Third Embodiment.

The embodiment of the present invention that will be described below is concerned with a navigation device comprising a data storage means (house shape data file) for storing building data for indicating the shapes of buildings, an input means for inputting points such as destinations and passing points (step 51 in Fig. 7, Fig. 36), a search means for searching, from the data storage means, a building that corresponds to a point input by said input means (step 51 in Fig. 7, Fig. 36), and a route calculation means (step 464 in Fig. 27) for searching a route regarding the building searched by the searching means as a destination, wherein the route calculation means calculates a route regarding a point on a road adjacent to the searched building as an end point of route.

21. Overall Circuitry.

The overall circuitry according to the third embodiment is nearly the same as the overall circuitry of the first embodiment shown in Fig. 1. The map data file stores road map data such as road map of the whole of the country and house map data of particular regions of major cities, towns and villages. The road map data comprises maps of a plurality of dissimilar scales covering the same region. The house map data may be data of a map of each of the regions or may be a plurality of map data of dissimilar scales.

22. Data Groups.

Fig. 20 illustrates some of the data groups stored in the RAM 4. The external data GD, present position data MP, absolute direction data ZD, relative direction angle data , travelled distance data ML, present position data PI, VICS data VD, ATIS data AD, registered destination data TP, guide route data MW, start point of route data SP, and end point of route data EP were described in the first embodiment. The drop-in place data DP are related to drop-in places set by the destination setting processing (step 51).

23. Road Data.

Fig. 21 illustrates some of the road data in the road data file stored in the data storage unit 37. The road data file includes data related to roads wider than a predetermined width in the region of a map stored in the map data file. When the number of roads included in the road data file is n, then, the road data related to roads of the number of n are contained in the road data file. The road data are constituted by road number data, guide object flag, road attribute data, shape data, guide data and length data.

The road number data are identification numbers attached to the roads divided by the intersecting points included in the map data. Therefore, a road number designates a road included in the road data file.

The guide object flag stores "1" when the road is to be guided and stores "0" when the road is not to be guided. The road to be guided is the one used for setting a guide route, i.e., is a road having a width larger than a predetermined value, such as a principal highway or a general road. The road that is not to be guided is the one which is not used for setting the guide route, i.e., is a road narrower than a predetermined width such as footpath or lane, or is a private road in the site.

The road attribute data represent kinds of attributes of roads such as high level road, underpass, expressway or toll road. The shape data represent shapes of roads and are constituted by coordinate data of a start point of road, end point of road, and coordinate data of nodes from the start point to the end point.

Fig. 22 illustrates the roads represented by the road data. Road numbers 1 to 14 are attached to the roads that are divided by intersecting points K1 to K7 in Fig. 22. The roads of road numbers 1, 4 and 14 have nodes N1 to N4. The nodes of the roads are provided maintaining a predetermined distance when the roads are straight. When the roads are curved, the nodes are provided in many number so that the roads can be approximated to straight lines.

Fig. 23 illustrates some of the roads on an enlarged scale. Each road has lanes in which the car runs in a direction opposite to the other. Separate road numbers L1 to L8 are attached to the lanes having different directions of progress. Here, however, the coordinates of intersections and nodes of pairs of roads are in common. For example, the start point Ka and the end point Kd of road numbers L1 and L2 share common coordinate data.

The guide data (Fig. 21) of the road data file include intersection name data, caution point data, road name data, road name voice data, and destination data. The intersection name data represent the name of an intersection when the end point of the road is the intersection. The caution point data are concerned with railroad crossing, inlet of a tunnel, outlet of a tunnel, reduction of the road width, etc. That is, the data related to points at which the driver must pay attention while he is driving on the road are caution point data. The road name voice data are pronunciation data of road names used for the guidance by voice. The length data are related to a length of a start point to an end point of a road, lengths from the start point to the nodes, and lengths among the nodes.

The destination data are related to a road (referred to as destination) connected to the end point of the road. The destination data is constituted by a number k of destinations and data at each of the destinations. The data related to a destination is constituted by destination road number data, destination name data, destination name voice data, destination direction data and running guide data.

The destination road number data are constituted by a road number of a road connected to the end point of a road. The destination name data are character data representing the names of the connected roads. The destination name voice data are to inform, by voice, the names of the connected roads. The destination direction data represents the directions of the connected roads. The running guide data are for making the user ready for entering into one of the connected roads from a road. The running guide data include data for urging the user to get into the right lane, into the left lane, or keep the central lane.

24. House Shape Data.

Fig. 24 illustrates house shape data of a section in the house shape data file. The structure of the house shape data of Fig. 24 is nearly the same as that of the house shape data of Fig. 5. The adjacent road data are constituted by number data of roads adjacent to the house shape and coordinate data of nodes of the roads. Here, the node included in the adjacent road data is the one which is closest to the house shape among the nodes included in the adjacent roads.

When there are a plurality of adjacent roads, the adjacent road data include the road number data and the coordinate data of the node which is closest to the house shape. In Fig. 25, for example, a road to be guided LD1 and a road to be guided LD2 are meeting at an intersection Kp. It is here presumed that the registered destination TP1 is adjacent to the road to be guided LD1 and to the road to be guided LD2.

The roads LD1 and LD2 are divided by the intersection Kp and are further divided into the right and left lanes. Therefore, the road LD1 is constituted by a road number LD1a and a road number LD1b. Similarly, the road LD2 is constituted by a road number LD2a and a road number LD2b. There further exist a road constituted by road numbers LD3a and LD3b and a road constituted by road numbers LD4a and LD4b.

Therefore, the adjacent road data of the house shape data at the registered destination TP1 is storing the road number LD1b and the road number LD2a. The house shape is a range surrounded by vertexes A to F, and the coordinate data of nodes ND1 and ND2 closest to the coordinates A, B, F facing the roads are stored in the adjacent road data.

In the case of Fig. 26, the registered destination TP2 is adjacent to a road LD5 that is not to be guided. In this case, the road number of the road LD5 that is not to be guided is stored in the adjacent road data. The road LD5 that is not to be guided is so narrow that it has only one lane. Depending upon the cases, however, the road that is not to be guided may have two lanes. When the road having two lanes but that is not to be guided is adjacent to the registered destination TP2, the road number of a lane closer to the registered destination TP2 is stored in the adjacent road data. In Fig. 26, furthermore, the coordinate data of the node ND6 closest to the registered destination TP2 are stored in the registered road data.

The particular coordinate data included in the house shape data are coordinate data of the entrance of a building or coordinate data of the entrance of a parking lot annexed to the building. That is, the particular coordinate data include coordinate data of a point which is most convenient for the user to enter into a place designated by the house shape data. For other data, reference should be made to the explanation of Fig. 5 of the first embodiment.

25. Overall Processing.

The overall processing according to the third embodiment is nearly the same as the overall processing of the first embodiment shown in Fig. 7.

The destination setting processing (step 51) executes a processing for setting the destination in the same manner as in the aforementioned first and second embodiments. The data related to the destination designated by the user are stored in the RAM 4 as the registered destination data TP. When the destination is designated on the house map picture, the house shape data of a place that is the destination are read out from the house shape data file. The house shape data serve as registered destination data TP. When the destination is designated on the road map picture, the destination data of a place that is the destination are read out from the destination data file. The destination data serve as the registered destination data TP.

Furthermore, a drop-in place is set on the way of the guide route in the same manner as that of setting the destination. That is, the data related to the designated drop-in place are stored, as drop-in place data DP, in the RAM 4. The destination setting processing (step 51) is not executed again unless a destination is newly set or a drop-in place is newly set.

The route search processing (step 52) searches a guide route up to the destination based upon the registered destination data TP, present position data MP and road data. The guide route is stored as guide route data MW in the RAM 4. The guide route data MW is constituted by road number data of the roads that connect the start point to the destination. A point on the road that is to be guided is regarded to be the end point EP of the guide route, the point being close to the destination that is registered in the destination setting processing (step 51).

The start point is the present position of the car or is a point on a road that is to be guided close to the present position. The start point is regarded to be a start point of route SP. When the drop-in place is set, a guide route is searched from the present position of the car that is running up to the drop-in position. The guide indication processing (step 53) is executed up to the drop-in position. When the drop-in place is reached, a guide route is automatically searched from the drop-in place to the end point of route EP. The guide indication processing (step 53) is executed along the guide route.

When the running position of the car has deviated from the guide route during the guide indication processing (step 53), the route search processing (step 52) is commenced to search a new guide route. The route search processing for searching a new guide route is commenced upon a predetermined switch operation, upon the input of voice or automatically. The new guide route is the one that connects a new position of the car to the drop-in place or to the destination. Therefore, the route search processing (step 52) is not executed again unless the car deviates from the guide route or unless a search command is input again by the user.

In the guide indication processing (step 53), voice information and vidual information are informed so that the user is possible to favorably drive his car along the guide route found by the route search processing (step 52). For instance, the guide route is indicated by a thick line of red, blue or any other conspicuous color on the map picture indicated on the display 33. Furthermore, the picture on the display 33 indicates the present position mark showing the present position of the car and the direction mark showing the direction of the destination or the drop-in place from the present position. The map picture indicating the guide route will be a road map in the vicinity of the present position or the house map in the vicinity of the present position. Instead of the road map, furthermore, there may be indicated a simple guide route picture indicating only a minimum of data such as guide route, direction to the destination or to the drop-in place, present position, etc., but omitting geographical data.

In the guide indication processing (step 53), the indicated map picture is changed over to the house map from the road map or from the simple guide route picture, or is changed over from the house map to the road map or to the simple guide route map. The map is changed over either manually by the user or automatically. When the running speed of the car is faster than the predetermined speed, for example, the road map or the simple guide route picture is indicated. When the running speed of the car is slower than the predetermined speed or when the car is halting, on the other hand, the road map or the simple guide route picture is changed over to the house map. When the car has approached the destination or the drop-in place within a predetermined distance, the road map or the simple guide route picture may be changed over to the house map.

26. Route Search Processing.

Fig. 27 is a flow chart of the route search processing (step 52). In this processing, the start point and the end point of the guide route are determined by a guide start point determining processing (step 460) and by a guide end point determining processing (step 462). The guide route includes a route up to the destination or up to the drop-in place registered from the present position of the car. Therefore, the start point of guide route is a start point and the end point of guide route is an end point. When the start point of route and the end point of route are determined, the most suited or a recommended route is searched to arrive at the end point of route from the start point of route (step 464).

This guide route is constituted by roads selected under predetermined conditions from the roads that are to be guided included in the road data file. The conditions for selecting the roads that constitute the guide route are that the guide route is the shortest, that main roads are much used, and that the user is able to

smoothly arrive at the end point of route EP. The road number data constituting the guide route are stored, as guide route data MW, in the RAM 4.

27. Processing for Determining Start Point of Route.

Fig. 28 is a flow chart of a processing for determining start point of route (step 460) executed in the route search processing (step 52). Narrow roads and private roads having a width narrower than a predetermined width are the roads that are not to be guided. The roads that are not to be guided are never used as the road for starting the guide route. When the present position of the car is on a road that is not to be guided or on a parking lot which is not the road, it becomes necessary to search a point on the road that is to be guided which is closest to the present position of the car. In the processing for determining the start point of route, therefore, a point which exists on the road that is to be guided and which is closest to the present position is searched in case the present position does not exist on the road that is to be guided. The point on the road that is to be guided is regarded to be a start point of route SP.

Described below is the order of processing for determining the start point of route. First, the present position data MP representing the present position of the car are read out from the RAM 4 (step 472). It is determined whether or not the point represented by the present position data MP exists on a road that is to be guided (step 474). The data of roads to be guided are searched from the road data file. it is determined weather the data of roads to be guided include road data having a node in agreement with the coordinates of the present position data MP. When there are the road data that are in agreement, it is then determined that the present position exists on a road that is to be guided.

When the present position exists on a road that is to be guided, then, the present position data MP are stored, as start point of route data SP, in the RAM 4 (step 484). When the present position does not exist on the road that is to be guided, then, the start point data and node data on a road to be guided that exist within a predetermined distance from the present position are read out (step 476). Distances are calculated from the present position to the start point data and to the node data that are read out (step 468). The distances found in the steps 468 are compared with each other to find the start point or node (which is a point at the shortest distance) of the road that is to be guided within the shortest distance from the present position (step 480). When there are a plurality of points at the shortest distance, the one closest to the registered destination TP or to the drop-in place DP is selected. The coordinates at the shortest point are stored, as start point of route data SP, in the RAM 4 (step 482).

A perpendicular is drawn from the coordinates of the present position onto a straight line connecting the coordinates of the point at the shortest distance found at the step 480 to a start point or a node adjacent to the point at the shortest distance. The coordinates of a point where the perpendicular meet the straight line may be used as a start point of route. In this case, the start point of route is a point closer to the present position than that of when the point at the shortest distance is used as the start point of route. When there exist a plurality of intersecting points, the one which is closest to the present position is used as the start point of route.

28. Processing for Determining End Point of Route.

Fig. 29 is a flow chart of a processing for determining end point of route (step 462) executed in the route search processing (step 52). First, the registered destination data TP are read out from the RAM 4 (step 490). It is determined whether the registered destination data TP are the house shape data or not (step 492). When the destination is designated on the house map picture in the destination setting processing (step 51), the registered destination data TP are house shape data.

On the other hand, when the destination is designated on the road map picture, the registered destination data TP are the destination data. A flag is added to the registered destination data TP to indicate a difference between the house shape data and the destination data. It is therefore determined depending upon the flag whether the registered destination data TP are house shape data or not. Here, when the registered destination data TP are the house shape data, then, the adjacent road data in the house shape data are read out (step 494). The coordinate data of a node in the adjacent road data thus read out are stored, as end point of route data EP, in the RAM 4 (step 496).

On the other hand, when it is determined at the step 492 that the registered destination data TP are not the house shape data, then, a road to be guided closer to the registered destination data TP is searched from the road data file. Then, a point is found which is an end point of the road to be guided or a node on the road and which exists within a predetermined distance from the registered destination TP (step 498). For instance, a plurality of points are calculated on a circle of a predetermined radius with the coordinates of the registered destination TP as a center. The coordinates of the plurality of points are compared with the coordinates of end points and nodes included in the road data. It is then determined whether the end points or nodes of roads to be guided are within the predetermined distance from the registered destination TP.

Next, distances are calculated from the end points and nodes found at the step 498 to the registered destination TP (step 500). For instance, differences are found on the latitude and longitude between the coordinates of the end points or nodes and the coordinates of the registered destination TP. The distances are calculated based upon the differences in the latitude and in the longitude and in compliance with the Pythagorean theorem. Then, the distances found at the step 500 are compared with each other. Thus, an end point or a node

(which is the final point) at the shortest distance from the registered destination TP is found (step 502). The coordinates of the final point are stored, as the end point of route data EP, in the RAM 4 (step 504).

A perpendicular is drawn from the coordinates of the registered destination onto a straight line connecting the coordinates of the final point found at the step 502 to the coordinates of the end point or the node adjacent to the final point. The coordinates of a point where the perpendicular meets the straight line may be used as the end point of route. In this case, a point closer to the registered destination than when the final point is used as the end point of route, can be used as the end point of route. When there exist a plurality of intersecting points, the one closest to the registered destination among such intersecting points can be used as the end point of route.

29. Guide Route Search Processing.

Fig. 30 is a flow chart of a guide route search processing (step 464) executed in the route search processing (step 52). First, the start point of route data SP, end point of route data EP and registered destination data TP are read out from the RAM 4 (step 510). It is then determined whether the registered destination data TP are house shape data or not (step 512). When a destination is designated on the house map picture in the destination setting processing (step 51), the registered destination data TP are house shape data as described earlier. When the destination is designated on the road map picture, the registered destination data TP are the destination data.

Here, when the registered destination data TP are the house shape data, then, the adjacent road data in the house shape data are read out (step 514). It is then determined whether the adjacent road data that are read out include roads that are not to be guided (step 516). For example, the road data in agreement with the road number in the adjacent road data are read out from the road data file. Depending upon whether the guide object flag in the road data are off or not, it is determined whether the roads are the ones that are to be guided or not.

When the adjacent road data include roads that are not to be guided, destination road number data included in the road data related to the roads that are not to be guided are read out. By using the guide object flag, the road numbers of the roads to be guided are searched from the destination road number data. Thus, there are read out the road numbers of the roads that are to be guided and are connected to the roads which are not to be guided. The road number data that are read out are stored, as continuing road number data LN, in the RAM 4 (step 518). When the adjacent road data include roads that are to be guided, on the other hand, the processing of the step 518 is not executed.

Next, the road numbers having the start point of route SP are searched from the road data file. The road numbers are written onto the first data area of the guide route data register MW in the RAM 4 (step 520). The roads to be guided that are connected to the above roads and that are more suited for arriving at the registered destination TP, are searched from the road data file (step 522).

The destination road number data in the road data (Fig. 21) are used for detecting the road numbers of roads connected to the road. The road attribute data and the destination direction data are utilized as the conditions for selecting more suitable roads to be guided. The selection conditions are that the major roads are preferentially used and that a road which is headed toward the registered destination TP is preferentially used.

The direction of the registered destination is found when the registered destination TP is set in the registered destination setting processing (step 51). The data indicating the direction of the destination are stored, as destination direction data MH, in the RAM 4. The direction of the registered destination is, for example, an angle of a straight line connecting the start point of route SP to the end point of route EP with respect to the absolute direction ZD. At the step 522, a road most advantageous for satisfying the above-mentioned conditions is selected out of a plurality of roads connected to the road. When there are selected a plurality of roads under the same conditions, the road is selected under further detailed conditions. For example, a road is picked up having the shortest distance from the start point of route to the end point of route. The road number of the thus picked-up road is added to the end of the data in the guide route data register MW (step 522).

Next, it is determined whether the road searched at the step 522 is an adjacent road or not (step 524). In other words, it is determined whether the road number data of the road searched at the step 522 are in agreement with the road number data in the adjacent road data or not. When the road is not the adjacent road, it is then determined whether the road searched at the step 522 is the road LN read out at the step 518 (step 540). When it is not the road LN, the program returns back to the step 522, and a next advantageous road that is to be guided and is connected, is searched from the road data file.

Therefore, the roads to be guided are successively searched until the adjacent road or the above-mentioned road LN is searched at the step 522. The road number data of the roads to be guided that are searched are added successively to the end of data of the guide route data register MW (steps 522, 524, 540).

When the road searched at the step 522 is the adjacent road, on the other hand, it means that the guide route is searched from the start point of route SP up to the registered destination TP. Accordingly, the road number data of the adjacent road are added to the end of data in the guide route data register MW (step 526). Then, the node data on the road searched at the step 522 are read out from the node data in the adjacent

road data. The coordinate data of this node are determined to be the end point of route data EP (step 528). The step 528 erases the end point of route data EP that are written onto the RAM 4 in the above-mentioned processing for determining end point of route (step 462). The end point of route data EP determined at the step 528 are newly written onto the RAM 4. When there are a plurality of end point of route data EP, therefore, any one of them is determined to be the end point of route.

Referring, for example, to Fig. 25, when the guide route is the one running from the upper side to the lower side of the road LD1b, the road number of the adjacent road LD1 is written onto the final data area of the guide route data register MW. The coordinate data of the node ND1 are determined to be the end point of route data EP. When the guide route includes the road LD3b or LD4b, the adjacent road LD2a is determined to be the final guide road connected to the roads LD3b and LD4b. Therefore, the road number of the adjacent road LD2a is written onto the final data area of the guide route data register MW. Besides, the coordinate data of the node ND2 are determined to be the end point of route data EP. At the step 522, the continuing roads are picked up based on a prerequisite that the end point of route EP is the node of the adjacent road. Therefore, the guide route is not the one that approaches from the right side of the road LD2b.

When the road searched at the step 522 is not the adjacent road (step 524) but is the road LN searched at the step 518 (step 540), the road number data of the road LN are written onto the end of the guide route data register MW (step 542). Then, the road number data of the adjacent roads connected to the road LN are read out from the adjacent road data. The road numbers of the adjacent roads connected to the road LN are added to the end of the guide route data register MW (step 544).

For example, when there are a plurality of roads adjacent to the registered destination TP, the road data in agreement with the road numbers of the adjacent roads are read out from the road data file. There are searched the road data which include a road number of the road LN in the destination road number data. The road number of the thus searched road data is that of the adjacent road connected to the road LN. The coordinate data of a node of the adjacent road connected to the road LN are read out from the node data in the adjacent road data. The coordinate data that are read out are determined to be the end point of route data EP (step 546). Like the above-mentioned step 528, this step 546, too, erases the end point of route data EP written onto the RAM 4 in the processing for determining end point of route (step 462). Instead, the end point of route data EP determined at the step 546 are newly written onto the RAM 4.

In Fig. 26, for example, the road numbers of the roads LD2a and LD2b are stored in the RAM 4 as a road LN connected to an adjacent road LD5 (step 518). When the guide route is a route that approaches from the left side of the road LD2a or from the right side of the road LD2b, the road number of the road LD2a or of the road LD2b is written onto the guide route data register MW (step 542). Moreover, the road number of the adjacent road LD5 is written onto the final data area of the guide route data register MW (step 544). The coordinate data of a node ND6 on the adjacent road LD5 are determined to be the end point of route data EP (step 546).

On the other hand, when it is determined at the step 512 that the registered destination data TP are not the house shape data, the road numbers of roads having the start point of route SP are searched from the road data file. The road number data that are searched are written onto the first data area of the guide route data register MW (step 530). Then, the roads to be guided connected to the above road and are advantageous for arriving at the registered destination TP, are searched from the road data file (step 532). The road number data of the thus searched roads are written onto the next data area of the guide route data register MW (step 534). The processings in these steps 532 and 534 are the same as that of the step 522.

Next, it is determined whether the roads searched at the step 532 includes the end point of route EP or not (step 536). For example, the coordinate data of nodes included in the road data of roads searched at the step 532 are read out. It is determined whether the coordinate data of these nodes are in agreement with the coordinate data of the end point of route EP. When there is no node that is in agreement with the end point of route EP, the program returns back to the step 532 to search the next road that is to be guided (step 532). Accordingly, the roads to be guided are successively searched until there is searched a road having the end point of route EP. The road numbers of the roads to be guided that are searched are added to the end of the guide route data register MW (steps 532, 534, 536).

When a road having the end point of route EP is searched, the result of discrimination at the step 536 becomes YES. The node on the thus searched road is determined to be the end point of route EP. There may, for example, exist a plurality of end point of route data EP that are written onto the RAM 4 in the step for determining end point of route (step 462). When there are a plurality of end points of route as searched at the step 462, the end point of route in agreement with the node on the guide road searched by the guide route search processing at the step 464 is stored, as the end point of route data EP, in the RAM 4 (step 538).

When the drop-in place is set, a guide route for arriving at the drop-in place is searched in the same manner as that of searching a guide route to the registered destination. The processing for searching the guide route to the drop-in place is the processing for determining start point of route (step 460), the processing for determining end point of route (step 462) or the guide route search processing (step 464) in which the

registered destination data TP are replaced by the drop-in place data DP.

When the destination or the drop-in place is set on the house map according to this embodiment, a guide route is searched based upon the adjacent road data included in the house shape data (step 464). When the house map is indicated in the guide indication processing (step 53), the registered destination or the drop-in place is indicated as a house shape in the house map. Besides, a guide route is indicated on the house map up to a node on a road adjacent to the house shape or up to a node at a position closest to the registered destination or the drop-in place. When there are a plurality of adjacent roads, therefore, the final point that is best guided is selected out of the nodes on the plurality of adjacent roads.

When the registered destination is set on the road map, furthermore, the adjacent road data are not used (steps 530 to 538 in Fig. 30) in the guide route search processing (step 52). In this case, the guide route is constituted by using only those roads that are to be guided. Therefore, the end point of route EP may not often exist on a road adjacent to the destination. It may, hence, often happen that the end point of route EP is a little separated away from the destination or the drop-in place. Accordingly, it may not often be able to quickly arrive at the destination or the drop-in place from the end point of route EP.

When the registered destination is set on the house map, on the other hand, the adjacent road data are used (step 514 in Fig. 30) in the guide route search processing (step 52). The adjacent road data may often include roads that are not to be guided. Therefore, the guide route includes the roads that are not to be guided. Besides, the guide route is searched up to a road adjacent to the registered destination. That is, the guide route is searched up to just before the destination.

30. Embodiment Using Particular Coordinate Data (Fourth Embodiment).

In the above-mentioned embodiment (third embodiment), when the destination or the drop-in place is the house shape data, the node of a road adjacent to the house shape is regarded to be the end point of route. Therefore, the guide route is searched up to a point from where the destination or the drop-in place can be easily and quickly arrived at. In the embodiment described below, a guide route is searched up to a point closer to a particular point such as entrance of a building at the destination or at the drop-in place or entrance of a parking lot based upon the particular coordinate data in the house shape data.

In this embodiment, the RAM 4 is provided with a register for storing designated position data IZ and particular adjacent road number data SN (see Fig. 20). The designated position data IZ represent a designated position selected by the user out of the particular coordinate data in the house shape data. The particular adjacent road number data SN represent road number data of the adjacent road on which the designated position exists. An arrival point designation processing (step 550) shown in Fig. 31 is executed in the destination setting processing (step 51 in Fig. 7). Fig. 32 illustrates a processing for determining end point of route (step 462) according to the fourth embodiment. Fig. 33 illustrates a guide route search processing (step 464) according to the fourth embodiment. These processings will now be described.

31. Arrival Point Designation Processing (Fig. 31) according to the Fourth Embodiment.

Fig. 31 illustrates a flow chart of the arrival point designation processing (step 550) executed by the destination setting processing (step 51). Before this processing is commenced, the destination is designated by the user as mentioned earlier. The destination data or the house shape data at the designated destination are stored in the RAM 4 as the registered destination data TP. After the registered destination data TP are stored in the RAM 4, the arrival point designation processing is started.

It is first determined whether the registered destination TP is stored in the RAM 4 or not (step 552). When the destination has been registered, it is then determined whether the registered destination data TP are house shape data or not (step 554). When the destination is designated on the house map picture as described above, the registered destination data TP are the house shape data. When the destination is designated on the road map picture, on the other hand, the registered destination data TP are the destination data.

Here, when the registered destination data TP are the destination data, it is not possible to search the house shape data at the destination. Therefore, the particular position cannot be determined, and the arrival point designation processing (step 550) ends. This is because, the particular position utilizes the data read out from the house shape data.

Therefore, when the registered destination data TP are the house shape data, particular coordinate data are read out (step 556) from the house shape data that have been stored as the registered destination data TP. The contents of the particular coordinate data are indicated on the display 33 (step 558). To the particular coordinate data have been added the picture data that are to be indicated on the display 33 together with the coordinate data at a particular position. Based upon the picture data, a picture related to the particular coordinates is indicated on the display 33. When the particular coordinate data are those of the entrance of a building and of the entrance of a parking lot, characters "ENTRANCE OF A BUILDING" and "ENTRANCE OF A PARKING LOT" are indicated on the display 33.

It is then determined whether a particular position is selected by the user or not (step 560). Relying upon the picture indicated on the display 33, the user selects any

desired position. When a particular position is selected, the coordinate data at the selected particular position are stored in the RAM 4 as designated position data IZ.

32. Processing for Determining End Point of Route according to the Fourth Embodiment.

Fig. 32 illustrates a flow chart of a processing for determining end point of route executed in the route search processing (step 52). In Fig. 32, the same steps as those of the processing for determining end point of route (Fig. 29) of the above-mentioned third embodiment, are denoted by the same reference numerals. First, registered destination data TP are read out from the RAM 4 (step 490). It is then determined whether the registered destination data TP are the house shape data or not (step 492). When the registered destination data TP are the house shape data, then, designated position data IZ are read out from the RAM 4 (step 570). Moreover, adjacent road data are read out from the house shape data that are the registered destination data TP (step 572).

Distances are calculated between the nodes included in the adjacent road data and the coordinates of the designated position data IZ (step 574). The node closest to the designated position is found (step 576). Coordinate data of the thus found node are stored in the RAM 4 as the end point of route data EP (step 578). The road number data of the adjacent road having the node that is the end point of route is stored, as particular adjacent road number data SN, in the RAM 4 (step 580).

On the other hand, when it is determined at the step 492 that the registered destination data TP are not the house shape data, the road data file is searched. Points that exist within a predetermined distance from the registered destination TP are found (step 498), the points being the end point and node on a road to be guided included in the road data file. Distances are calculated between the registered destination and the end point and node found at the step 498 (step 500). Then, the distances found at the step 500 are compared with each other. The end point or the node on the road to be guided whichever is closest to the registered destination is regarded to be the end point of route (step 502). Coordinates of the end point are stored, as end point of route data EP, in the RAM 4 (step 504).

33. Guide Route Search Processing according to Fourth Embodiment.

Fig. 33 illustrates a flow chart of a guide route search processing executed in the route search processing (step 52). In Fig. 33, the steps same as the steps of the guide route search processing (Fig. 30) of the third embodiment are denoted by the same reference numerals. First, start point of route data SP, end point of route data EP and registered destination data TP are read out from the RAM 4 (step 510). Then, it is determined whether the registered destination data TP are the house shape data or not (step 512).

When the registered destination data TP are the house shape data, particular adjacent road data SN are read out from the RAM 4 (step 590). It is then determined whether the particular adjacent road data SN that are read out include roads that are not to be guided (step 516). For instance, road data in agreement with a road number in the particular adjacent road data are read out from the road data file. It is determined whether the guide object flag of the road data that are read out is off or not. When the guide object flag is off, then, the road is the one that is not to be guided.

Here, when the particular adjacent road data SN include a road that is not to be guided, the road numbers of roads connected to the road that is not to be guided are read out from the destination road number data included in the road data of the road that is not to be guided. The thus read-out road numbers are stored, as continuing road number data LN, in the RAM 4 (step 518). When the particular adjacent road data SN include no road that is not to be guided, on the other hand, the processing at the step 518 is not executed.

Then, road numbers that include the start point of route SP are searched from the road data file. These road numbers are written onto the first data area of the guide route data register MW in the RAM 4 (step 520). Then, the most suitable road to be guided that is connected to the roads and that arrives at the registered destination TP is searched from the road data file (step 522). The road numbers of the roads connected to the road are found from the destination road number data in the road data shown in Fig. 21. The most suitable road to be guided is searched by utilizing the road attribute data and the destination direction data.

At the step 522, therefore, the most suitable road to be guided is picked up out of a plurality of roads connected to the road. The road number data of the roads that are picked up are added to the end of the guide route data register MW (step 522).

Next, it is determined whether the road searched at the step 522 is a particular adjacent road or not (step 592). When it is not the particular adjacent road, it is, then, determined whether the road searched at the step 522 is the road LN that is read out at the step 518 or not (step 540). When it is not the road LN, the program returns back to the step 522 where the most suitable road to be guided that is to be connected next is searched. Therefore, the most suitable roads to be guided are successively searched at the step 522 until the adjacent road or the road LN is searched, and are added to the end of the guide route data register MW (steps 522, 592, 540).

On the other hand, when the road searched at the step 522 is the particular adjacent road, it means that the guide route has arrived at the registered destination TP. In this case, the road number of the particular adjacent road is written onto the final data area of the guide route data register MW (step 594). The end point of route data EP existing on this particular adjacent road

are regarded to be the sole end point of route data EP (step 596). At the step 596, a plurality of end point of route data EP written onto the RAM 4 in the end point of route-determining processing (step 462) are erased, and the end point of route data EP determined at the step 596 are written. Thus, when there are a plurality of end point of route data EP, only one of them is determined.

Referring to Fig. 25, it is now presumed that the house shape data at the registered destination TP1 include two particular coordinate data TZ1 and TZ2. Here, the user may designate the particular coordinates TZ2. In this case, the designated position data IZ are regarded to be the particular coordinate data TZ2 (step 562 in Fig. 31). The end point of route EP is the node ND2 which is closest to the particular coordinate TZ2 (step 578 in Fig. 32). The particular adjacent road number SN is the road number of the adjacent road LD2a that includes the node ND2 (step 580).

When the guide route is connected from the upper direction of the road LD1b, the node ND1 may be close to the registered destination TP1 but is not closest to the particular coordinate TZ2. Therefore, the node ND1 is excluded from the end point of route EP. The node closest to the particular coordinate TZ2 is the node ND2. Therefore, the node ND2 is regarded to be the end point of route EP. The road number of the particular adjacent road LD2a is written onto the final data area of the guide route data register MW (step 594).

When the road LD3b or the road LD4b is a guide route, the particular adjacent road LD2a is preferentially picked up as a road that connects to the road LD3b or LD4b. This is because, the particular adjacent road LD2a includes the node that is closest to the particular coordinate TZ2. Therefore, the road number of the adjacent road LD2a is added to the end of the guide route data register MW. Besides, the coordinate data of the node ND2 are determined to be the end point of route data EP.

As for searching the guide route, the continuing roads are searched based on a prerequisite that the end point of route EP is a node on the particular adjacent road. Therefore, the guide route never approaches from the right direction of the road LD2b. When the particular coordinate TZ1 is designated by the user, therefore, the end point of route EP becomes the node ND1. The particular adjacent road is the road LD1b, and a guide route in which the node ND1 is the end point is a sole route that approaches from the upper direction of the particular adjacent road LD1b.

On the other hand, when the road searched at the step 522 is not the particular adjacent road (step 592 in Fig. 33), it is determined whether the road that is searched is the road LN that is read out at the step 518 or not (step 540). When the searched road is the road LN, the road number data of the road LN are written onto the end of the guide route data register MW (step 542).

Then, the road number data SN of the particular adjacent road connected to the road LN are read out. The road number data SN are written onto the final data area of the guide route data register MW (step 600). The coordinate data of the node on the particular adjacent road read out from the adjacent road data are determined to be the end point of route data EP (step 602). Even in this step 602 like in the above-mentioned step 596, the end point of route data EP written onto the RAM 4 in the end point of route-determining processing (step 462) are erased. The end point of route data EP determined at the step 602 are newly written onto the RAM 4.

Referring, for example, to Fig. 26, the registered destination TP2 has a particular coordinate TZ3 and an adjacent road LD5. Therefore, the end point of route EP is a node ND6 (step 578 in Fig. 32). The particular adjacent road is a road LD5 (step 580 in Fig. 32). Therefore, the road numbers of the roads LD2a and LS2b are stored in the RAM 4 as roads LN connected to the adjacent road LD5 (step 518). When the guide route is connected from the left side of the road LD2a or is connected from the right side of the road LD2b, the road number of the road LD2a or LD2b is added to the end of the guide route data register MW (step 542).

Moreover, the road number of the particular adjacent road LD5 is written onto the final data area of the guide route data register MW (step 600). The coordinate data of the node ND6 on the adjacent road LD5 are determined to be the end point of route data EP (step 546).

On the other hand, when it is determined at the step 512 that the registered destination data TP are not the house shape data, the following processing is executed. The road numbers of roads having the start point of route SP are searched from the road data file. The thus searched road number data are written onto the initial data area of the guide route data register MW (step 530). Then, the road to be guided that is connected to the roads and that most suitably arrives at the registered destination TP is searched from the road data file (step 532). The road number data of the searched road are written onto the final data area of the guide route data register MW (step 534).

Then, it is determined whether the road searched at the step 532 includes the end point of route EP or not (step 536). When there is no end point of route EP, the program returns back to the step 532 where a next most suitable road to be guided that connects to the road is searched (step 532). The roads to be guided are successively searched until a road having the end point of route EP is searched. The road number data of the searched road are added to the end of the guide route data register MW (steps 532, 534, 536).

When a road having the end point of route EP is searched, the result of discrimination at the step 536 becomes YES. The end point of route EP on the searched road is regarded to be a sole end point of route EP (step 538).

When there are a plurality of particular adjacent

roads, the particular adjacent road determined as a road to be guided is a road that is searched at the step 522 or is a particular adjacent road that is connected to the above road (step 600). The end point of route EP is limited to the node on this road (steps 596, 602).

When a drop-in place is set, a guide route that arrives at the drop-in place is set through the same processing as the processing for setting a guide route up to the registered destination. The processing for setting the guide route up to the drop-in place is the processing for determining the start point of route (step 460), the processing for determining the end point of route (step 462), the guide route search processing (step 464) or the arrival point designation processing (step 550) in which the registered destination data TP are replaced by the drop-in place data DP.

34. Fifth Embodiment.

In the third and fourth embodiment, the adjacent road data in the house shape data are constituted by road numbers of roads adjacent to the house shape and coordinates of a node closest to the house shape. Here, the shape data of the house is constituted by a plurality of coordinate data forming a plane figure. A flag data may be added to the coordinate data adjacent to the road among the coordinate data of the shape data. The flag data represent that the coordinate is adjacent to the road. Hereinafter, this flag is referred to as adjacent flag.

As represented by a broken line in Fig. 20, furthermore, the RAM 4 is provided with a register for storing the adjacent road data LD. The adjacent road data LD are the road number data of roads adjacent to the house shape at the registered destination TP. Therefore, the adjacent road data in the house shape data have not been provided in the fifth embodiment. In the fifth embodiment, the road data may not distinguish the roads to be guided over the roads that are not to be guided. Therefore, the processing for determining the end point of route (step 462) according to the fifth embodiment is shown in Fig. 34. The guide route search processing (step 464) according to the fifth embodiment is shown in Fig. 35.

35. Processing for Determining End Point of Route according to the Fifth Embodiment.

Fig. 34 is a flow chart illustrating the processing for determining the end point of route (step 462) according to the fifth embodiment. In Fig. 34, the same steps as the steps of the processing for determining the end point of route of Fig. 29 are denoted by the same reference numerals. First the registered destination data TP are read out from the RAM 4 (step 490). It is then determined whether the registered destination data TP are the house shape data or not (step 492). When the registered destination data TP are the house shape data, the shape data are read out from the house shape data (step 610). Then, the coordinate data to which the adjacent flag is attached are searched out of the shape data that are read out (step 612).

Then, end points or nodes are searched that exist within a predetermined distance from the coordinate to which the adjacent flag is attached out of the road data in the road data file (step 614). Then, distances are calculated between the end points or nodes searched at the step 614 and the coordinates to which the adjacent flag is attached (step 616). The distances found at the step 616 are compared. From the result of comparison, the end point or node at the shortest distance is found for each of the coordinates to which the adjacent flag is attached (step 618).

The road number having the end point or node found at the step 618 is searched from the road data file. The road of this road number is the one which is adjacent to the registered destination TP. The road number data of this adjacent road are stored, as adjacent road data LD, in the RAM 4 (step 620).

The road data are searched having shape data that meet the coordinate data of the end point or the node found at the step 618. From the road data is picked up a road number of a lane of the side close to the coordinates of a vertex to which is added the adjacent flag of the house shape. In this case, the road attribute data include lane data representing whether the lane is on the right side or on the left side of the center line.

The coordinates of the end point or the node found at the step 618 are regarded to be a base point. It is determined in which direction (north, south, east or west) from the base point are existing the coordinates of the vertex to which the adjacent flag is attached. This direction is compared with the lane data to detect the adjacent road. The coordinates of the end point or the node found at the step 618 are stored in the RAM 4 as the end point of route data EP (step 504).

On the other hand, when it is determined at the step 492 that the registered destination data TP are not the house shape data, the steps 498 to 502 are executed. The end points and nodes on the roads to be guided within a predetermined distance from the registered destination TP are found (step 498). Distances are correctly calculated between the end points or nodes and the registered destination TP (step 500). The distances found at the step 500 are compared. The end point or the node having the shortest distance is regarded to be the end point (step 502). The coordinates of the end point are stored, as the end point of route data EP, in the RAM 4 (step 504).

36. Guide Route Search Processing according to the Fifth Embodiment.

Fig. 35 is a flow chart illustrating the guide route search processing according to the fifth embodiment. In Fig. 35, the same steps as the steps of the guide route search processing of Fig. 30 are denoted by the same reference numerals. First, the start point of route data SP, end point of route data EP and registered destina-

tion data TP are read out from the RAM 4 (step 510). Next, it is determined whether the registered destination data TP are house shape data or not (step 512). As described above when a destination is designated on a house map picture in the destination setting processing (step 51), the registered destination data TP are the house shape data. When the destination is designated on the road map picture, the registered destination data TP are the destination data.
Here, when the registered destination data TP are the house shape data, then, the adjacent road data LD stored in the RAM 4 are read out (step 630).

Next, a road number having the start point of route SP is searched from the road data file. The road number is written onto the initial data area of the guide route data register MW in the RAM 4 (step 520). Then, a road connected to this road and that is most suited for arriving at the registered destination TP is searched from the road data file. The road number of the thus searched road is added to the end of the guide route data register MW (step 632).

It is then determined whether the road searched at the step 632 is the adjacent road or not (step 524). In other words, it is determined whether the road number data of the road searched at the step 632 are in agreement with the road number data of the adjacent road data LD or not. When it is not the adjacent road, the program returns back to the step 632 where a next continuing road is searched. At the step 632, therefore, the most suitable roads are successively searched until the adjacent road is searched. The road number data of the searched road are added to the end of the guide route data register MW (steps 632, 524).

On the other hand, when the road searched at the step 632 is the adjacent road, it means that the guide route has arrived at the registered destination TP. Therefore, the road number data of the adjacent road are written onto the final data area of the guide route data register MW (step 526). The end point of route on the adjacent road is determined to be the end point of route data EP (step 634). At the step 634, the end point of route data EP written onto the RAM 4 in the processing for determining the end point of route (step 462) are erased. Instead, the end point of route data EP determined at the step 634 are newly written onto the RAM 4. When there are a plurality of end point of route data EP, one of them is determined. At the step 620 of Fig. 34, the road numbers of the adjacent roads and the end points of route located thereon are stored being related to each other in the RAM 4.

Referring, for example, to Fig. 25, the shape data in the house shape data at the registered destination TP1 are constituted by the coordinate data of vertexes A to F. The adjacent flag is attached to the coordinate data of vertexes A, B and F that are adjacent to the roads LD1b and LD2a. Therefore, the end point of route-determining processing (Fig. 34) determines the end points or the nodes at the shortest distances from the vertexes A, B and F (step 618 of Fig. 34). In this case, the nodes ND1 and ND2 are detected. However, it is not possible to stop the car at the center of the intersection. Therefore, the intersection Kp is excluded from the recommended end point of route.

For example when the guide route is connected to the upper side of the road LD1b, the node ND1 is determined to be the end point of route EP (step 538 in Fig. 35). When the guide route is connected to the road LD3b or to the road LD4b, the adjacent road LD2a is preferentially picked up as a road connected to these roads LD3b and LD4b. Accordingly, the road number of the adjacent road LD2a is written onto the final data area of the guide route data register MW (step 526 in Fig. 35). The node ND2 is determined to be the end point of route data EP (step 634 in Fig. 35). At the step 632, a continuing road is picked up based on a prerequisite that the end point of route EP is a node on the adjacent road. Therefore, the guide route is never connected to the right side of the road LD2b.

On the other hand, when it is determined at the step 512 that the registered destination data TP are not the house shape data, the processings on and after the step 530 are executed. The road number of a road having the start point of route SP is searched from the road data file. The searched road number data are written onto the first data area of the guide route data register MW (step 530). Then, a road connected to this road and which is most suited for arriving at the registered destination TP is searched from the road data file (step 636). The road number data of the searched road are added to the end of the guide route data register MW (step 534).

Next, it is determined whether the road searched at the step 636 has the end point of route EP or not (step 536). When there is no end point of route EP, the program returns back to the step 532 where a next continuing road that is most suited is searched (step 636). Therefore, the continuing roads are successively searched until the road having the end point of route EP is searched. The road number data of the searched road are added to the end of the guide route data register MW (steps 636, 534, 536). When the road having the end point of route EP is searched at the step 636, the result of discrimination at the step 536 becomes YES. In this case, the end point of route EP on the searched road is regarded to be the sole end point of route EP (step 538).

When a drop-in place is set, a guide route that arrives at the drop-in place is searched in the same manner as in the processing for searching a guide route up to the registered destination. The processing for searching the guide route up to the drop-in place is the processing for determining the start point of route (step 460), the processing for determining the end point of route (step 462), or the guide route search processing (step 464) in which the registered destination data TP are replaced by the drop-in data DP.

37. Sixth Embodiment.

The navigation device of the embodiment described below is characterized by the provision of the following means.

(1) Data storage means (house shape data file) for storing building data that represent the shape of a building.
(2) Input means for inputting desired genres (step 644 in Fig. 36).
(3) Search means for searching, from the data storage means, a building that corresponds to the genre that is input through the input means (step 648 in Fig. 36) .
(4) Cursor position detection means for detecting the position of the cursor (step 660 in Fig. 36).
(5) Building search means for searching a building corresponding to the detected cursor Position (step 662 in Fig. 36).
(6) Indication means (display 33) for indicating buildings corresponding to genres input through the input means in a first indication form (step 658 in Fig. 36) and for indicating buildings searched by the building search means in a second indication form (step 664 in Fig. 36).

39. Point Setting Processing according to the Sixth Embodiment.

Fig. 36 is a flow chart of the point setting processing (step 640) according to the sixth embodiment. It is, first, determined whether the car is running or not (step 642). When it is determined that the car is running, the point setting processing is not executed. That is, the point setting processing can be executed only when the car is halting or is running at a very slow speed.

When it is determined that the car is halting, it is then determined whether an instruction for setting a point by utilizing genre is input or not (step 644). When the point is set utilizing the genre, a genre list is indicated on the display 33. The genre selected by the user is determined (step 646). A plurality of points that meet the selected genre are indicated on the display 33 (or are output by voice). The point selected by the user is determined by using a touch switch provided on the display 33.

The selected facility or point is searched from the data storage means (step 648). It is determined whether a house map capable of indicating the searched point is stored in the data storage unit 37 or not (step 650). The house map that is stored is indicated with the above-mentioned point as a center (step 656). Here, it is determined whether the map that is now being indicated on the display 33 is the road map or not (step 652). When the road map is being indicated, preparation is carried out for indicating the house map. That is, the reduced scale of the road map that is now being indicated is stored in the RAM 4 (step 654).

Buildings corresponding to the input genre are searched from the house shape data. The buildings are indicated in the first indication form (step 658). In the first indication form, color, brightness or brilliancy is changed from the steady state. Thus, the buildings corresponding to the selected genre can be easily distinguished over other buildings.

Next, the cursor is used for designating a particular point on the map picture that is indicated. Therefore, the position of the cursor indicated on the map is detected (step 660). Next, a building corresponding to the position of the cursor is searched from the house shape data (step 662). The building that is searched is indicated in the second indication form (step 664). In the second indication form, the first indication form is further changed. For instance, the indicated building has a further increased brightness. This makes it possible to more easily distinguish the point designated by the cursor. The second indication form may be in any form provided it gives a distinction over the points indicated in the first indication form.

The object indicated in the second indication form is always a point that is designated by the cursor. For instance, the cursor is moved to a building indicated in the first indication form. Then, the indication form of the building designated by the cursor is changed into the second indication form. As the cursor is further moved from this building to designate another building, the building that had been designated before is returned back to the first indication form (step 666).

It is further determined whether indication of detailed data related to buildings is requested or not (step 668). When the indication is requested, detailed data of a building designated by the cursor is informed (guidance by indication, guidance by voice)(step 670). The character "RETURN" is indicated on the picture on the display 33. It is determined whether the user has touched the indication of character "RETURN" or not (step 680). When it is touched, the point setting processing of Fig. 36 ends.

When the character "RETURN" is not touched, it is determined whether the processing for registering the point is requested or not (step 682). When the processing for registering the point is requested, the point designated by the cursor is registered (step 684). The point setting flag is then turned on (step 686). When the point is registered, the point setting processing ends.

On the other hand, when it is determined that the data storage unit 37 is not storing the house map that includes the selected point (step 650 is NO), the processings on and after the step 672 are executed. At the step 672, it is determined whether the map being indicated on the display 33 is a road map or not (step 672). When a house map is being indicated, the reduced scale data of the map stored in the RAM 4 are read out (step 674). Then, the road map is indicated according to the reduced scale data that are read out (step 676).

Next, the position of the cursor on the road map is

detected (step 678). The point designated by the cursor can now be registered (steps 682, 684, 686). When the desired point is not found during the processing, the character "RETURN" on the display 33 is touched to end the processing (step 680).

40. Route Search Processing According to the Sixth Embodiment.

Fig. 37 is a flow chart of a route search processing (step 700). First, a destination input by the user is searched from the data storage means (step 702). When the destination that is searched exists in the house map data, roads adjacent to the destination are searched from the house map data (step 704). The adjacent roads can be stored in advance in the house shape data. From the house shape, furthermore, the roads having coordinates in common with the coordinates of the destination can be set as adjacent roads.

Next, it is determined whether particular data such as point data like entrance, exit, parking lot, etc. are stored in the house shape data at the destination that is input or not (step 706). When there are particular data, a node on the closest road is searched based on the particular data. The node on the road is set as end point of route (steps 708, 710). That is, it is presumed that the entrance data have been stored as particular data in the house shape data at the destination that is input. The node on the road closest to the entrance can be regarded to be the end point of route based upon the particular data. Even when there are a plurality of adjacent roads, therefore, a guide route can be reliably set up to a point desired by the user.

The user may request, for example, "GUIDE ME TO A PARKING LOT", "GUIDE ME TO THE FRONT GATE", "GUIDE ME TO THE EXIT TO MEET A GUEST", etc. Therefore, a plurality of particular data may be stored in the house shape data. In this case, the particular data at the destination are so constituted as can be selected by the user. This enables the user to cope with a variety of requests.

Next, a route is searched from the present position detected by the present position detection means up to the end point of route that is calculated above (step 712). When the particular data are not contained in the house shape data, a node closest to the point at the center of the house shape is searched. Thus, the end point of route is set (step 714), and the route is searched up to the destination (steps 710, 712).

41. Other Modified Embodiments.

The present invention is in no way limited to the above-mentioned embodiments only but can be changed in a variety of ways without departing from the gist of the invention. In the aforementioned embodiments, for example, a list of detailed data related to the destination is indicated in response to the switching operation by the user (steps 100, 102 in Fig. 9). However, detailed data related to the house shape designated by the center KLC of the cursor may be automatically indicated on the display 33, instead. Furthermore, the house shape designated by the center KLC of the cursor may be indicated in red color or like color that can be distinguished over other house shapes. A solid picture representing the appearance of that place may be indicated at the position of the house shape or at a position where an associated object is indicated such as leader or the like.

In the aforementioned embodiments, the house shape has a unit of a building or of a facility. However, the house shape may be such that a plurality of buildings in a facility constitute a unit. The house shape may further be such that a section of the town constitutes a unit. Or, a plurality of neighboring buildings may constitute a unit. The house shape data in the above-mentioned embodiments have been constituted by coordinate data of vertexes of the plane house shape. The house shape data, however, may be constituted by coordinate data of the sides that define the outer circumference of the plane house shape. Or, the house shape data may be constituted by coordinate data maintaining a predetermined interval included in the plane house shape. Moreover, the house shape data may be constituted by coordinate data of vertexes of a plane figure that expresses on a plane the solid appearance of the place. Similarly, the house shape data may be constituted by the coordinate data on the sides of a plane figure of a solid appearance or by the coordinate data maintaining a predetermined interval included in the plane shape. In the case when the solid appearance of the house shape is expressed on a plane, the house shape data having the center KLC of the cursor on the plane shape may be searched at the step 98 in the destination designation processing (Fig. 9). It is further allowable to search the house shape data having the center KLC of cursor on the plane section such as of a site, etc.

When the house shape is such that a section of the town constitutes a unit, the external data representing the shape of the section of the town and the internal data of the buildings are stored in the data storage unit 37 being related to each other. In this case, there may be further stored the internal data of the buildings and the external data such as shapes of the buildings being related to each other.

The house map may not be indicated on the display 33 but particular coordinates may be designated on the road map by the cursor. The house shape data that have the designated coordinates may be searched. In this case, the searched house shape data are stored in the RAM 4 as registered destination data TP. The house map may not include the house shape. For instance, places such as roads, rivers, etc., excluding buildings, are closely indicated, but the buildings are not indicated. When a destination is to be set, coordinates designated on the map by the cursor KL or the like are searched. The house shape data having the thus searched coordi-

nates may be searched. Even in this case, the searched house shape data are stored in the RAM 4 as the registered destination data TP.

The house map may be the one from which the whole shape or part of the shape of a building, facility or bridge can be recognized relying upon coordinates. As for indicating the shape of buildings, the entire building included in the data may be indicated or may be indicated only when it is required. Moreover, the house shape data may be those for indicating the shape of a building or detailed data related to the building. The shape of a building is formed as data. Upon identifying the shape of a building, it becomes possible to search the building at a point that is input, and the user finds it simple and easy to input a desired building. When the shape of a building is indicated on the picture by utilizing the shape data of the building, furthermore, the point that is now being indicated can be perceived more reliably. In other words, the point can be recognized more reliably.

In the foregoing was described the touch switch input as input means. It is, however, also allowable to employ joy stick input, remote control input, voice input, or the like input, as a matter of course.

In the above-mentioned embodiments, furthermore, the present position, destination or center of the cursor is brought to the center of the picture when the house map or the road map is indicated on the display 33. It is, however, also allowable to indicate on the display 33 the map having other coordinates at the center of the picture. For instance, when it is desired to widely indicate the forward direction of progress, a point in front of the present position by a predetermined distance may be brought to the center of the picture.

In the foregoing were described embodiments in which the house shape at a recommended drop-in place was indicated in blue (step 366 in Fig. 18) and the house shape having the center KLC of cursor was indicated in red or in a solid picture VS (step 372 in Fig. 18). However, there is no limitation on the color to be indicated and, besides, the brightness, brilliancy or pattern over the range of the house shape may be changed, or the house shape may be flashed, or a mark such as arrow may be indicated to designate the house shape.

In addition to the position of the house shape at a drop-in place, the solid picture may be indicated at a position where an associated object is indicated such as leader or the like.

The house map and the road map may be changed over being selected by the user. The map to be indicated may further be selected depending upon the genre of drop-in place designated by the user. The map may be further selected depending upon whether the present position of the car is inside or outside the range of the house map data. The map may be selected depending upon whether or not a predetermined period of time has passed from the start of running of the car. The map may be selected depending upon the rotational speed of the engine. The map may be selected depending upon the time. The map may be selected depending upon the remaining amount of the fuel in the car. The map may be selected depending upon the temperature of the engine. The map may be selected depending upon the battery voltage. The map may be selected depending upon the brightness around the car. The map may be selected depending upon the atmospheric temperature around the car. The map may be selected depending upon the direction of progress of the car. The map may be selected depending upon the angle of the car with respect to the absolute direction. The map may be selected depending upon the altitude of the car.

At the step 60 of Fig. 8, at the step 294 of Fig. 17 and at the step 352 of Fig. 18, it was determined whether the car is halting or not depending upon whether the running speed of the car is 0 km/or slower than a predetermined speed. The predetermined speed may be a very slow speed, or may be a low speed or an intermediate speed.

The third and fourth embodiments have explained the cases where the road data contain roads that are to be guided and roads that are not to be guided. It is also allowable to use road data without having distinction between the roads to be guided and the roads not to be guided. That is, the guide route is searched using all of the road data stored in the data storage unit 37. In this case, none of the processings of the steps 516, 518, 540 to 546, 600 and 602 of Figs. 30 and 33 are required.

In the fourth embodiment, the particular coordinates designated by the user may be determined to be the end point of route and a guide route may be set up to the particular coordinates. It is further allowable to find by calculation the adjacent roads based upon the shape data in the house shape data relying upon neither the adjacent road data nor the adjacent flag. By searching, for example, common coordinates between the road data and the house shape data, it becomes possible to search the adjacent roads.

The present invention may be a map indication device having the following features. That is, the device stores data related to buildings such as shapes and names of buildings (house shape data file). Besides, the map is indicated based upon the data (step 193 of Fig. 13, step 304 of Fig. 17, step 365 of Fig. 18), and the shapes (shape data) of the indicated buildings can be recognized. Moreover, the building at a point that is input may be searched and informed (step 199 of Fig. 13, step 370 of Fig. 18).

Above data storage unit 37 can be set to indoor computer or the other computer, accordingly the above navigation process can be executed at the other place than the car. For example the navigation process is displaying the map, simulated moving from the present position to the destination or calculation distance along roads among any points in the map.

Above programs and/or data can be sent (transmitted) from outside system to the flash memory 3 via data transmitter / receiver unit 27. The outside system is

Supplying system for present position information or Information process center of ATIS (Auto Traffic Information Service). This outside system is provided at a long distance from the navigation device. This sent programs are also installed (transferred / copied) automatically to the flash memory 3 when the programs sent to the navigation device or an operator instructs (operates).

Above described route search processing (step 52) the process for determining start point of guide route (step 460) the process for determining end point of guide route (step 462) guide route search processing (step 464) and/or point setting processing (step 640) etc. can be executed at the outside system. The process results and map information are sent (transmitted) from the outside system to the navigation device. Displaying road information and guiding route are executed at the navigation device based upon received the process results and map information. In this case, road information, map information, establishment information and traffic jam information are processed and controlled collectively in the outside system, therefore better guiding route and setting point are executed.

The programs can be installed to the RAM 4 from the data storage unit 37 automatically by setting the data storage unit 37 to the navigation device or powerring on the navigation device or instruction (operation) of operator. This installing is executed every when above powerring on the navigation device etc. because the programs and data can not be memorized non-volatilly in RAM. If reading speed of information from the data storage unit 37 is high, the CPU 2 can read and executed directly the programs stored in the data storage unit 37. The flash memory 3 can be RAM backed up by battery, IC memory card or EEPROM.

Claims

1. A map indication device which stores the data related to buildings such as the shapes of buildings and names of buildings,
   indicates the map based upon said data,
   and recognizes the shapes of the indicated buildings.

2. A map indication device which stores the data related to buildings such as the shapes of buildings and names of buildings,
   indicates the map based upon said data, and recognizes the shapes of the indicated buildings,
   thereby to search a building corresponding to a point that is input and to inform it.

3. A map indication device which stores external data of buildings such as plane shapes or solid shapes of a plurality of buildings or sites,
   reads the external data of said buildings that are stored,
   converts the external data of said buildings that are read out into data for indication,
   and indicates a map that represents external data of buildings based upon the converted external data of the buildings,
   so that the shapes of the buildings can be recognized on the map that is indicated.

4. A map indication device which stores external data of buildings such as shapes of buildings, stores internal data such as addresses,
   names and telephone numbers of the buildings in response to the external data of said buildings that are stored,
   indicates a map that represents external data of buildings based upon the external data of the buildings that are stored,
   discriminates the shapes of buildings from the map that represents the external data of the indicated buildings,
   searches the internal data corresponding to the determined buildings from said internal storage means,
   and informs the internal data of the searched buildings.

5. A map indication device which stores house shape data related to buildings such as shapes of buildings,
   outputs the map data based upon the house shape data,
   inputs a point based on the map data that are indicated,
   recognizes the shapes of buildings based upon said house shape data to search a building that corresponds to a point that is input,
   and informs a building that corresponds to the point that is input.

6. A navigation device which detects the present position of a car,
   stores the house shape data in which the shapes of buildings are constituted by sequences of coordinates,
   outputs the map data based upon the house shape data, inputs a point based upon the data that are indicated,
   compares the coordinates of the point that is input with the shapes of buildings constituted by the sequences of coordinates of said house shape data to search a building that corresponds to the coordinates of the point that is input,
   sets the searched building as a destination, calculates a route from the present position up to the destination that is set,
   informs a building that corresponds to the coordinates of the point that is input,
   and informs a route that is calculated.

7. A navigation device which stores house shape data

that are related to house shapes representing shapes of places that are included in a predetermined region and are sectionalized on a plane, positions of the places, and data related to the places,

designates, as a point, the place that becomes the destination, searches coordinates of the point that is designated,

searches house shape data in which the coordinates of the place that is searched are included in the range of said house shape based upon said house shape data,

sets the place represented by the searched house shape data as a destination,

sets a guide route up to the destination that is set,

indicates a picture, indicates data related to a place included in said searched house shape data,

detects the present position of a moving means,

and indicates the guide route that is set and the detected present position of said moving means.

8. A map indication device which stores a road map formed based upon road data and a house map formed based upon data related to buildings such as shapes of buildings, and changes over the map.

9. A map indication device which stores road data representing roads that are indicated as a map,

stores external data of buildings such as shapes of a plurality of buildings indicated as a map,

selects the road data or the external data of buildings,

reads either the road data or the external data of buildings depending upon the selection,

converts either the road data or the external data of buildings that are read out into data for being indicated as a map,

and indicates the converted road data or the external data of buildings as a map.

10. A navigation device which stores road map data formed based upon road data as well as house map data formed based upon data related to buildings such as shapes of buildings,

detects the present position of a car,

calculates a route based upon said data that are input and said map data that are stored when data necessary for calculating the route up to a destination are input,

guides the route based upon the calculated route and the detected present position of the car,

indicates the map data that are read out and the calculated route,

and indicates the map data formed by reading said road map data or the map data formed by reading said house map data upon judging predetermined conditions.

11. A navigation device according to claim 10, wherein the map to be indicated are changed over to the road map from the house map when it is judged that the speed of the car that is detected is higher than a predetermined speed.

12. A navigation device according to claim 10 or 11, wherein the map data to be indicated are selected either manually or automatically,

and the map data to be indicated are changed over depending upon the selection of the map data.

13. A navigation device according to claim 10,11 or 12, wherein a distance is calculated from said detected present position of the car to said destination that is input, and, based upon the remaining distance that is calculated, the map data to be indicated are changed over to the house map from the road map upon judging that the car is within a predetermined distance from the destination.

14. A navigation device which stores house shape data that are related to house shapes representing shapes of places that are included in a predetermined region and are sectionalized on a plane, positions of the places, and data related to places,

indicates a picture,

generates house map data to indicate a house map by using house shapes of places that are included in said predetermined region and are sectionalized on a plane,

indicates a house map based upon the house map data that are generated,

generates road map data to indicate a road map by using a road network and geographical data included in a predetermined region,

indicates a road map based upon the road map data that are generated,

designates a point that becomes a destination,

searches coordinates of the point that is designated,

searches the house shape data in which the coordinates of said searched point is included in the range of said house shape based upon said house shape data,

indicates data related to a place included in the searched house shape data,

regards the place represented by the searched house shape data to be a destination,

stores place data related to places that may be selected as drop-in places,

searches from said place data, the places that correspond to the selected genre and that meet

the conditions that are input as drop-in places,

indicates the house shape of the searched place on the house map in a form distinguished over house shapes of other places,

designates a drop-in place out of recommended drop-in places that are indicated,

indicates the house shape of the designated drop-in place in a form distinguished over the other recommended drop-in places, searches the coordinates of a point designated as the drop-in place,

searches the house shape data in which the coordinates of the point of said drop-in place is included in the range of said house shape based upon said house shape data,

regards the place represented by the searched house shape data as a drop-in place, sets a guide route up to the destination and a guide route up to the drop-in place, detects the present position of a moving means,

indicates the guide route together with said detected present position,

discriminates whether said present position is within a predetermined distance from the destination or not when the guide route is being indicated,

determines whether the house map or the road map be indicated depending upon predetermined conditions,

indicates the house map around the destination when said destination is set,

indicates the house map around the present position when it is so determined that the present position of the moving means is within the predetermined distance from said destination,

discriminates whether the range of the house map being indicated lies outside the coordinate range of the picture that is indicated or not,

changes over the indication of the house map to the road map when the range of the house map being indicated lies outside the coordinate range of the picture that is indicated,

stores the reduced scale of the road map when the road map being indicated is changed over to the house map,

indicates the road map again on the reduced scale that is stored when the road map that is indicated is changed over to the house map and when the house map is changed over again to the road map,

determines whether the house map or the road map be indicated depending upon the manual operation by the user,

discriminates whether said moving means is moving or not,

and inhibits the indication of the house map when it is determined that said moving means is now moving.

15. A navigation device which calculates a route up to a destination that is input and offers a guidance according to the route,

wherein said navigation device stores building data for indicating the shapes of buildings,

inputs a point such as a destination or a passing point,

searches from said building data, a building corresponding to the point that is input,

regards said searched building as the destination,

and calculates the route regarding a point on a road adjacent to said searched building as an end point of route.

16. A navigation device according to claim 15, wherein said building data further stores data of a particular point, said searched building is regarded as the destination, and a route is searched up to said particular point of said searched building.

17. A navigation device according to claim 16, wherein the data of said particular point are the data related to the inlet of a building.

18. A navigation device according to claim 16 or 17, wherein the data of said particular point are the data related to a parking lot.

19. A navigation device which calculates a route up to a destination that is input and offers a guidance along the route,

wherein said navigation device stores building data to indicate shapes of buildings,

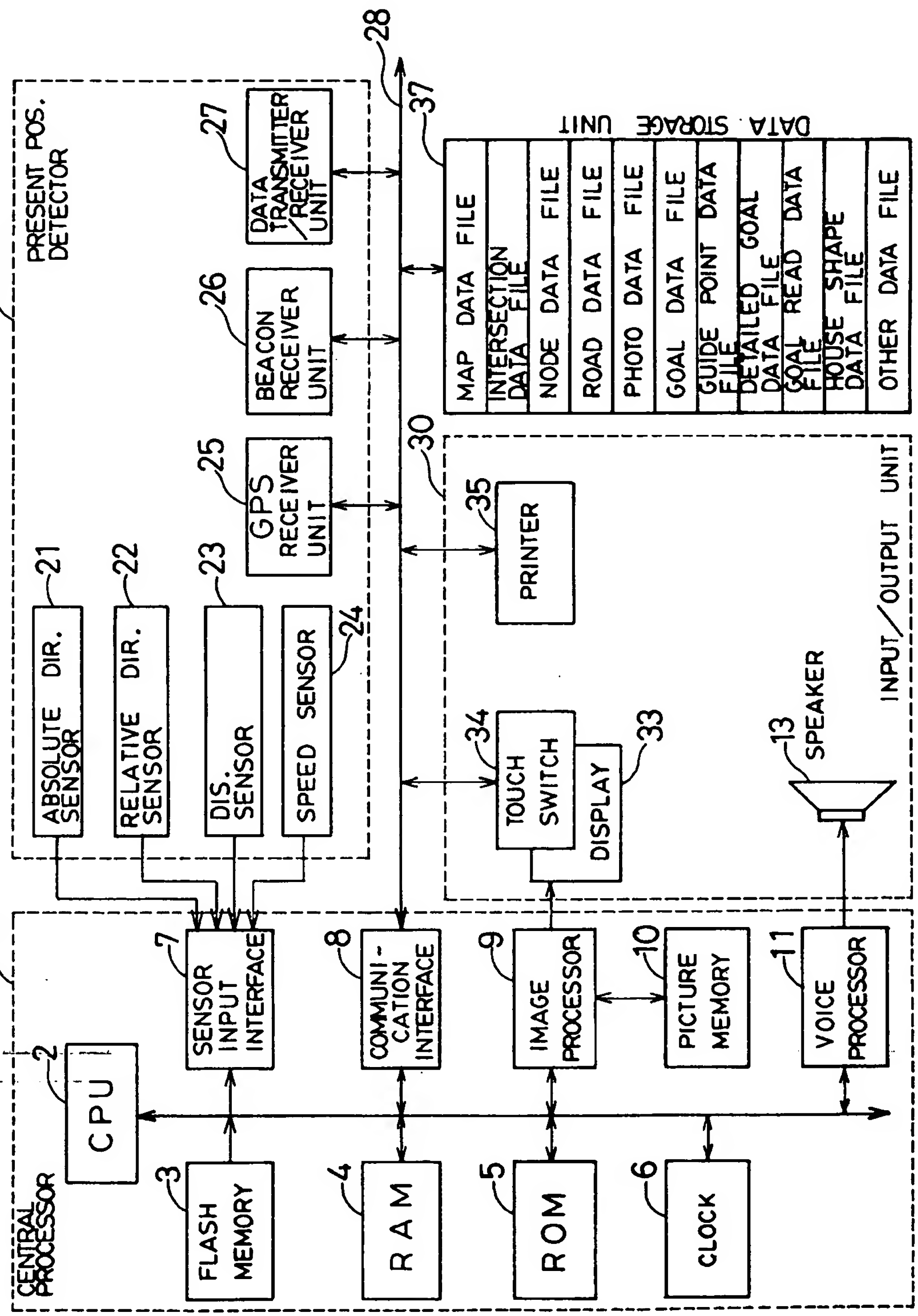
searches, from said building data, buildings that correspond to a genre of the destination that is input,

detects the position of the cursor,

searches a building that corresponds to the detected position of the cursor,

and indicates a building corresponding to the genre that is input in a first indication form and indicates a building searched from said building data in a second indication form.

FIG. 1



20
PRESENT POS. DETECTOR
21
ABSOLUTE DIR. SENSOR
22
RELATIVE DIR. SENSOR
23
DIS. SENSOR
24
SPEED SENSOR
25
GPS RECEIVER UNIT
26
BEACON RECEIVER UNIT
27
DATA TRANSMITTER /RECEIVER UNIT
28
37
DATA STORAGE UNIT
MAP DATA FILE
INTERSECTION DATA FILE
NODE DATA FILE
ROAD DATA FILE
PHOTO DATA FILE
GOAL DATA FILE
GUIDE POINT DATA FILE
DETAILED GOAL DATA FILE
GOAL READ DATA FILE
HOUSE SHAPE DATA FILE
OTHER DATA FILE
30
INPUT/OUTPUT UNIT
35
PRINTER
34
TOUCH SWITCH
33
DISPLAY
13
SPEAKER
1
CENTRAL PROCESSOR
2
CPU
3
FLASH MEMORY
4
RAM
5
ROM
6
CLOCK
7
SENSOR INPUT INTERFACE
8
COMMUNI-CATION INTERFACE
9
IMAGE PROCESSOR
10
PICTURE MEMORY
11
VOICE PROCESSOR

FIG. 2

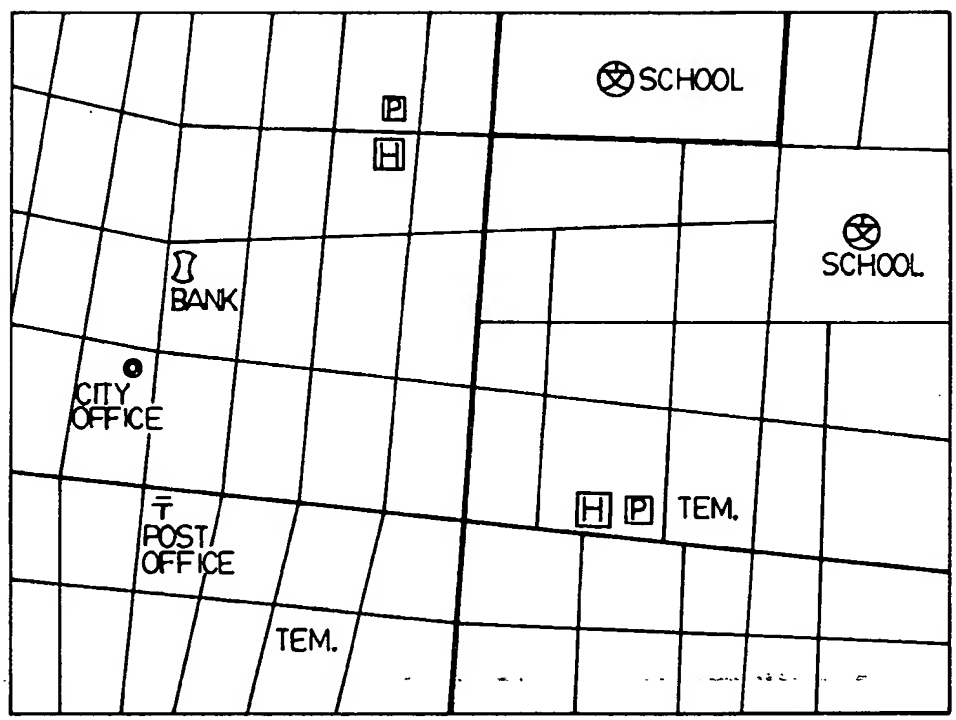


FIG. 3

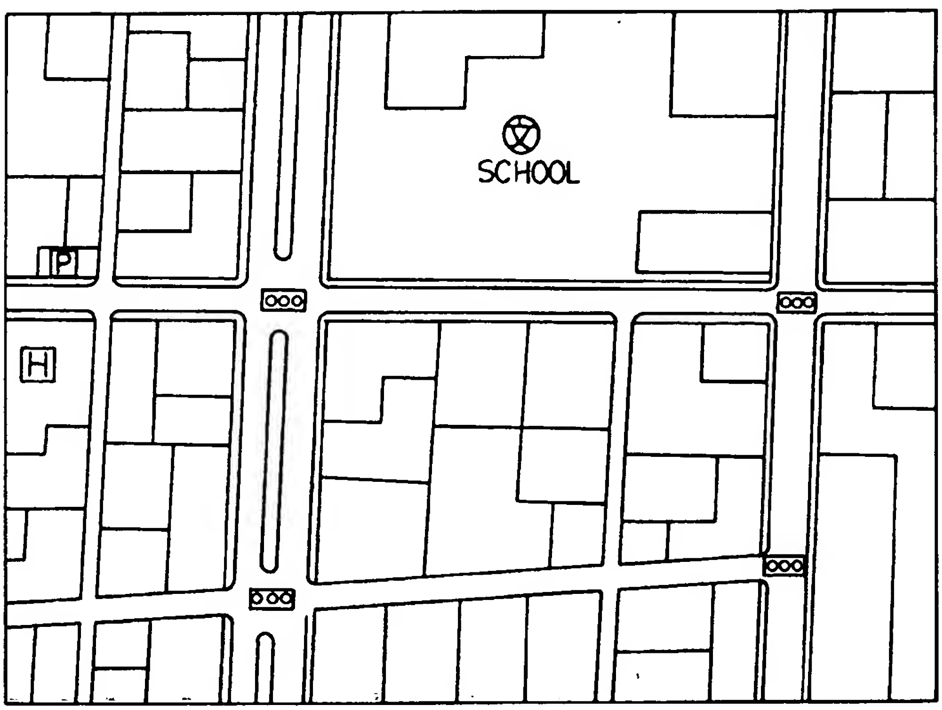


FIG. 4

RAM 4

EXTERNAL DATA	GD	PRESENT POS.	MP
ABSOLUTE DIR.	ZD	RELATIVE DIR. ANGLE	θ
DIS. TRAVELLED	ML	PRESENT POS. DATA	PI
VICS DATA	VD	ATIS DATA	AD
REGISTERED GOAL	TP	GUIDE ROUTE	MW
START POINT OF ROUTE	SP	END POINT OF ROUTE	EP

FIG. 5

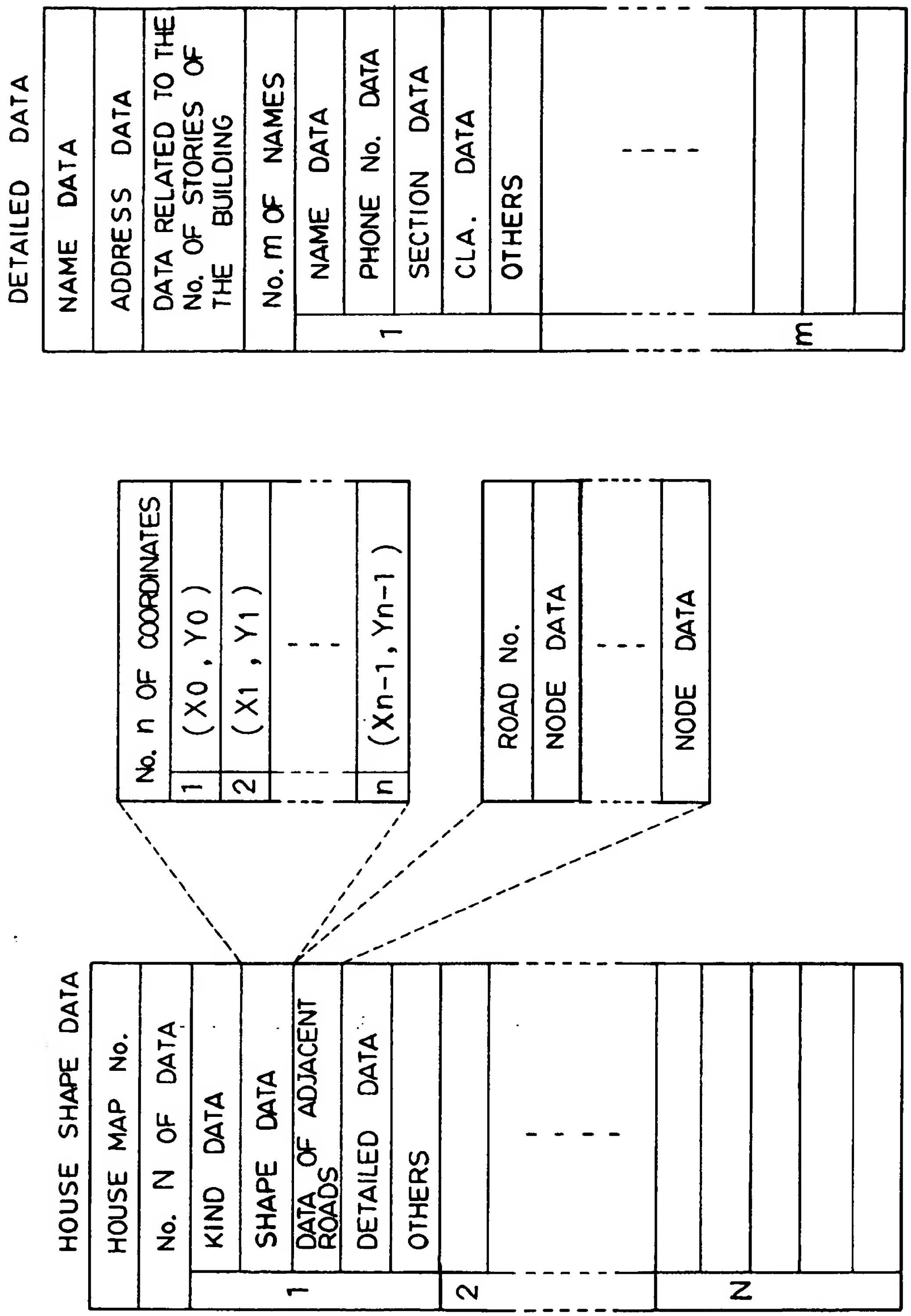

DETAILED DATA
NAME DATA
ADDRESS DATA
DATA RELATED TO THE No. OF STORIES OF THE BUILDING
No. m OF NAMES
NAME DATA
PHONE No. DATA
SECTION DATA
CLA. DATA
OTHERS
1
m
No. n OF COORDINATES
1
(X0 , Y0)
2
(X1 , Y1)
n
(Xn-1 , Yn-1)
ROAD No.
NODE DATA
NODE DATA
HOUSE SHAPE DATA
HOUSE MAP No.
No. N OF DATA
KIND DATA
SHAPE DATA
DATA OF ADJACENT ROADS
DETAILED DATA
OTHERS
1
2
N

FIG. 6

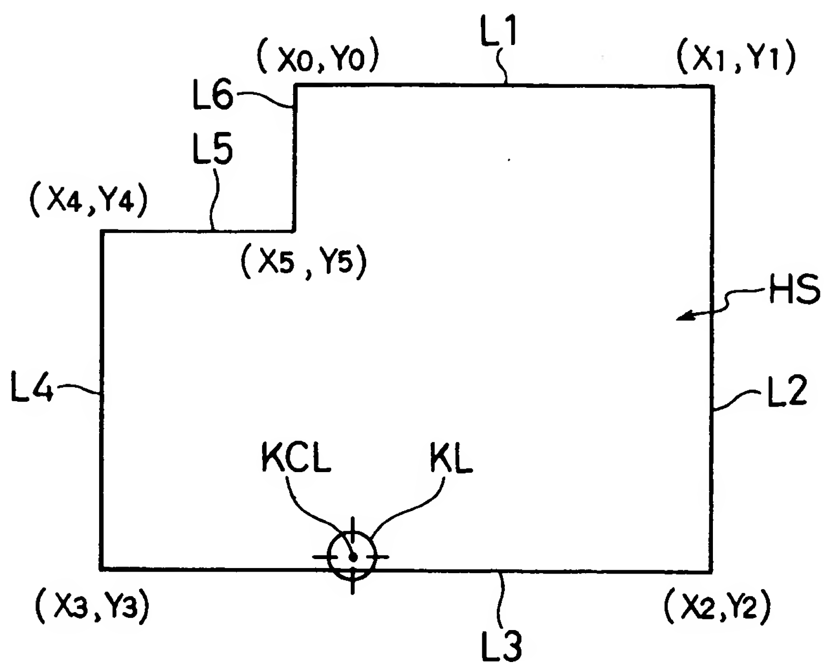


FIG. 7

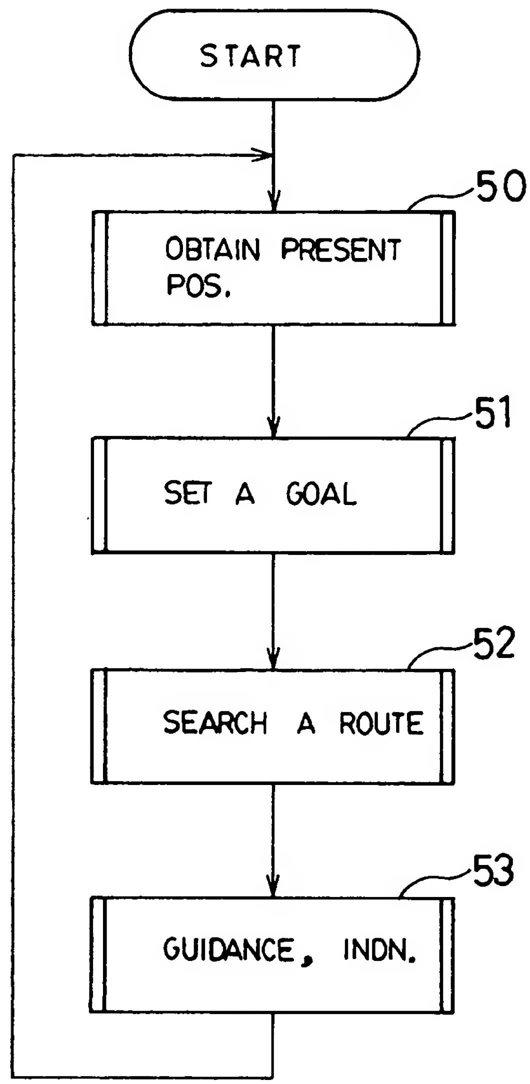

START
50
OBTAIN PRESENT POS.
51
SET A GOAL
52
SEARCH A ROUTE
53
GUIDANCE, INDN.

FIG. 8

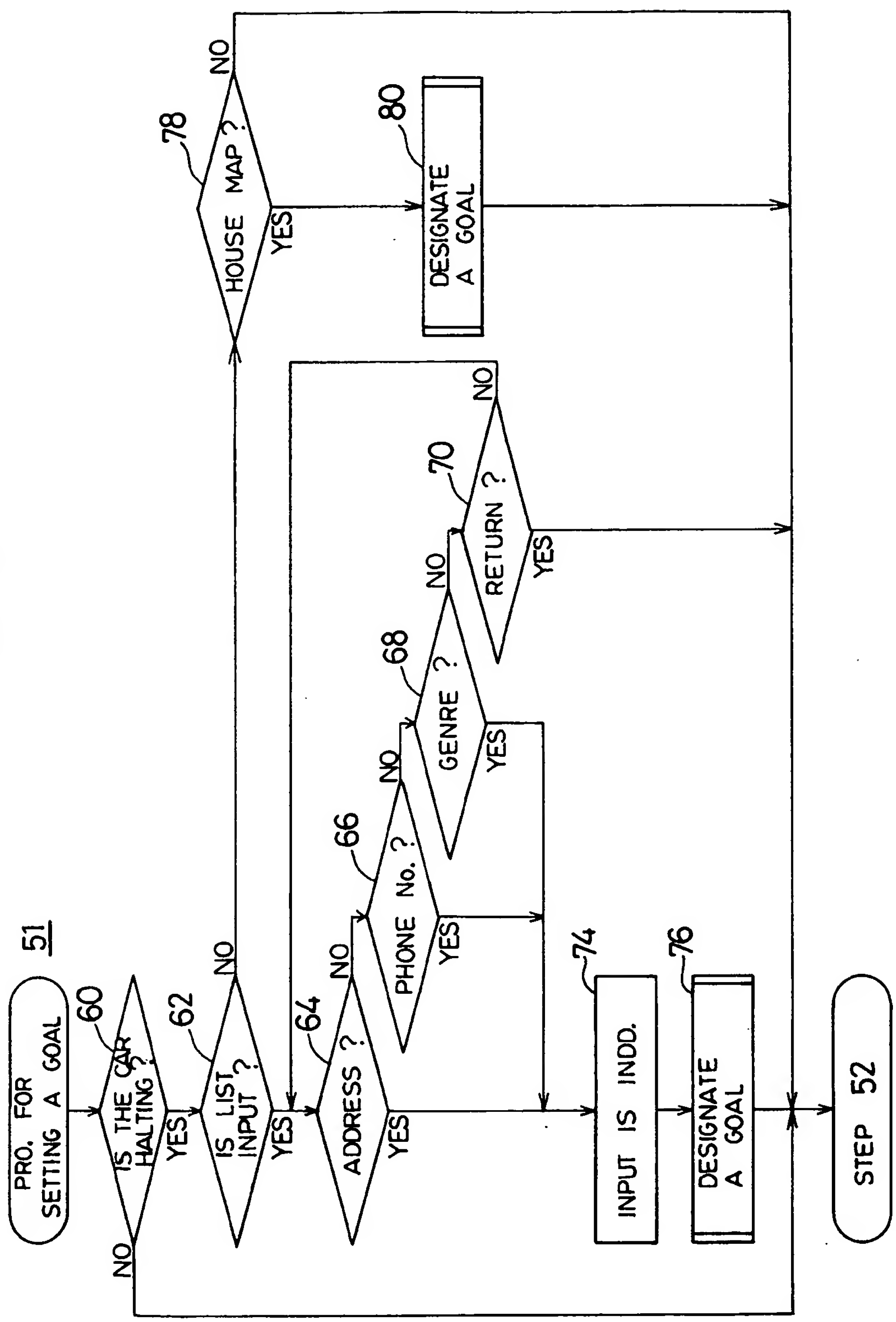

51
PRO. FOR SETTING A GOAL
IS THE CAR HALTING ?
IS LIST INPUT ?
ADDRESS ?
PHONE No. ?
GENRE ?
RETURN ?
HOUSE MAP ?
DESIGNATE A GOAL
INPUT IS INDD.
DESIGNATE A GOAL
STEP 52
YES
NO
60
62
64
66
68
70
74
76
78
80

FIG. 9

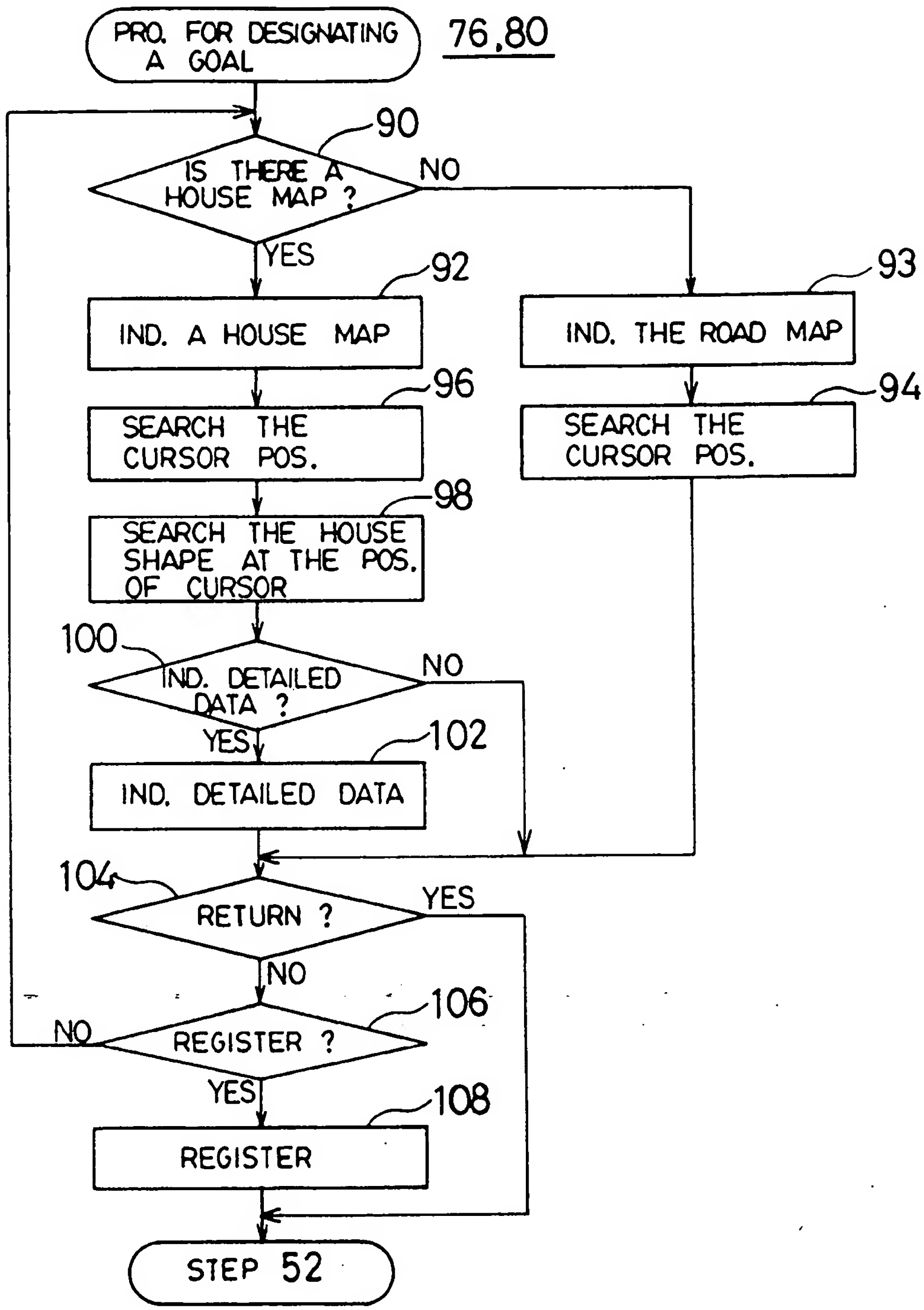

PRO. FOR DESIGNATING A GOAL
76,80
90
IS THERE A HOUSE MAP ?
NO
YES
92
IND. A HOUSE MAP
93
IND. THE ROAD MAP
96
SEARCH THE CURSOR POS.
94
SEARCH THE CURSOR POS.
98
SEARCH THE HOUSE SHAPE AT THE POS. OF CURSOR
100
IND. DETAILED DATA ?
NO
YES
102
IND. DETAILED DATA
104
RETURN ?
YES
NO
106
NO
REGISTER ?
YES
108
REGISTER
STEP 52

FIG. 10

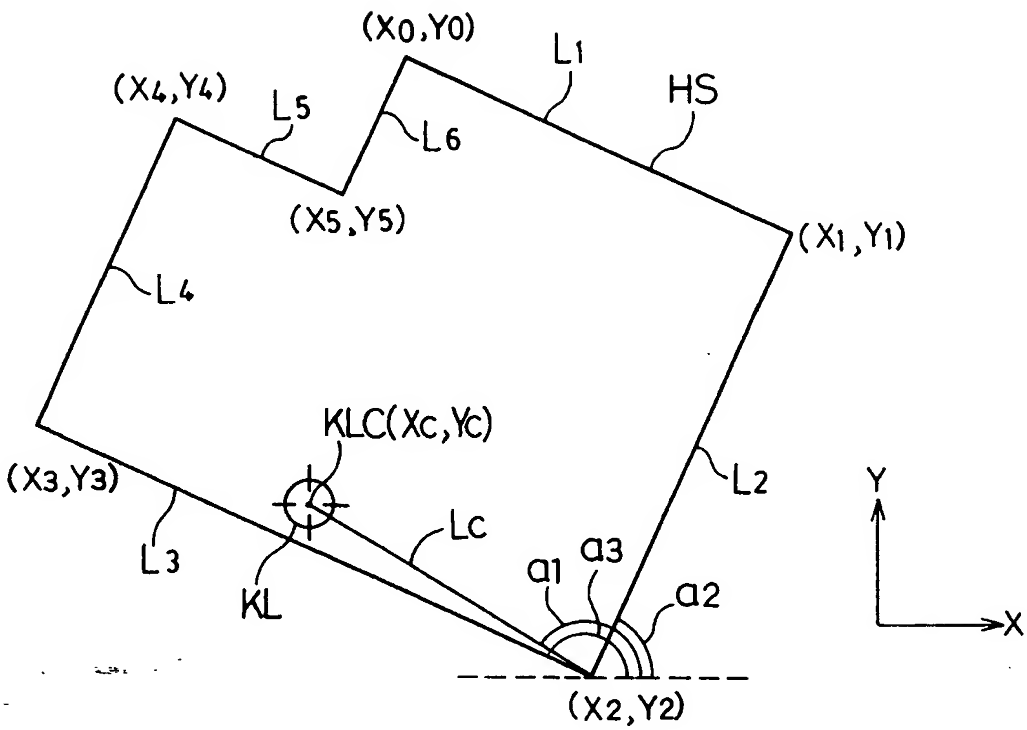

(X0,Y0)
L1
HS
(X4,Y4)
L5
L6
(X5,Y5)
(X1,Y1)
L4
KLC(Xc,Yc)
(X3,Y3)
L2
Y
L3
KL
Lc
a1
a3
a2
X
(X2,Y2)

FIG. 11

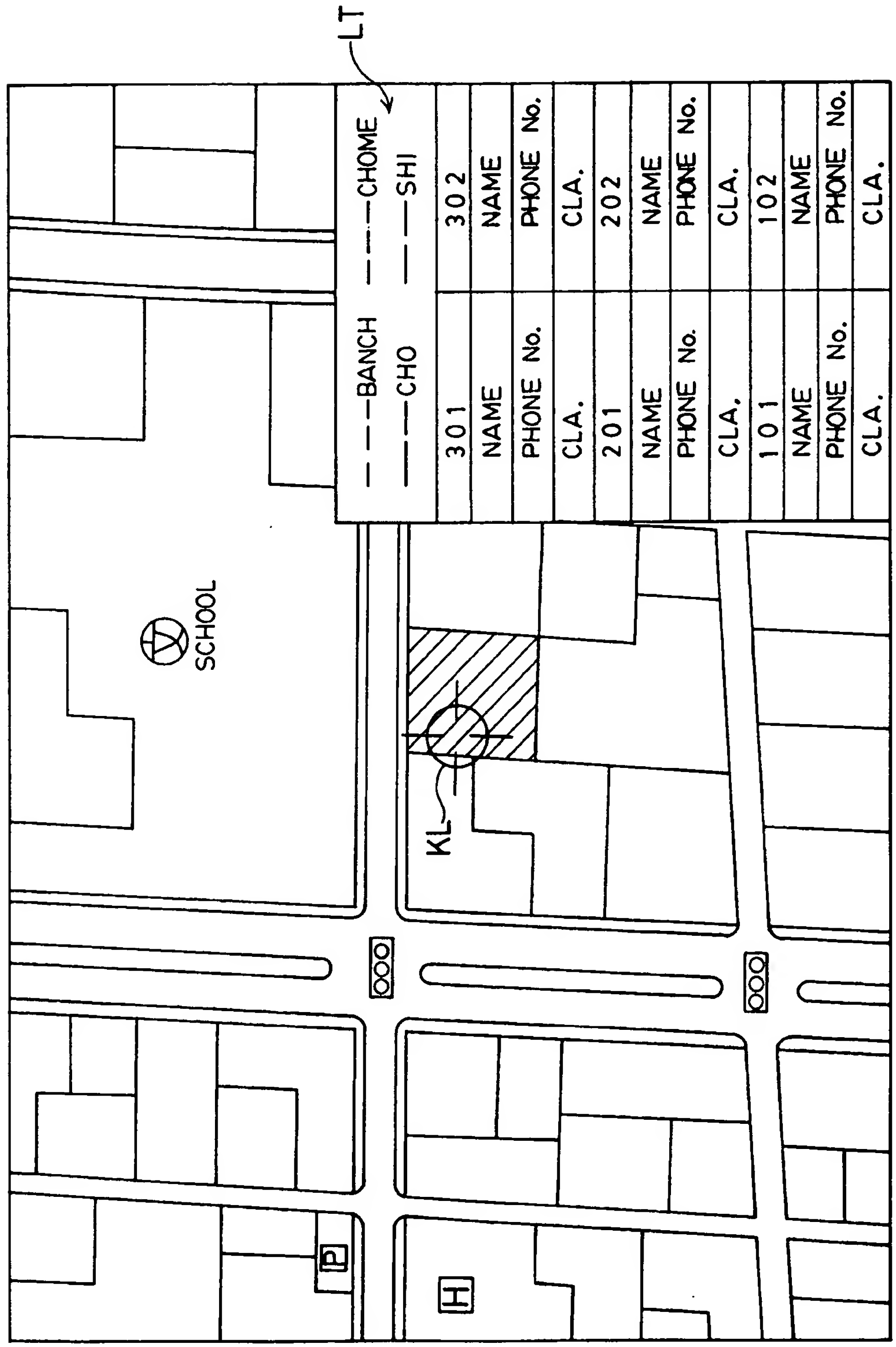

LT
BANCH
CHOME
CHO
SHI
301
NAME
PHONE No.
CLA.
302
NAME
PHONE No.
CLA.
201
NAME
PHONE No.
CLA.
202
NAME
PHONE No.
CLA.
101
NAME
PHONE No.
CLA.
102
NAME
PHONE No.
CLA.
SCHOOL
KL
P
H

FIG. 12

RAM4

EXTERNAL DATA	GD	PRESENT POS.	MP
ABSOLUTE DIR.	ZD	RELATIVE DIR. ANGLE	θ
DIS. TRAVELLED	ML	PRESENT POS. DATA	PI
VICS DATA	VD	ATIS DATA	AD
REGISTERED GOAL	TP	GUIDE ROUTE	MW
RUNNING SPEED	MV	START POINT OF ROUTE	SP
END POINT OF ROUTE	EP	HOUSE MAP INDN. FLAG	JF
REDUCED SCALE	SD	ROAD MAP INDN. FLAG	DF
DIS. TO THE GOAL	MD	MANUAL INDN. FLAG	MF
HOUSE MAP BEING INDD. FLAG	HF		

RECOMMENDED DROP-IN PLACE	DK	PLACE TO BE DROPPED IN	DP
RANGE OF SEARCH	SA	SEARCH CONDITION	KJ
DROP-IN PLACE SETTING FLAG	TF		

FIG. 13

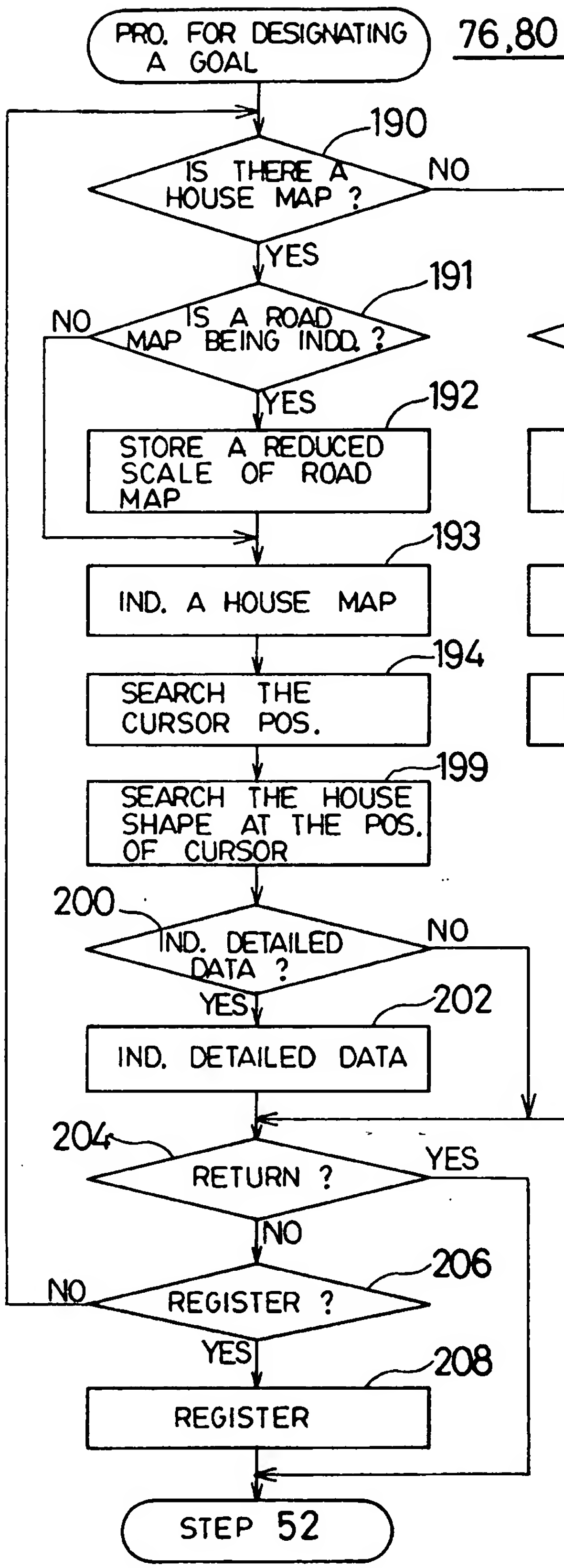

PRO. FOR DESIGNATING A GOAL
76,80
190
IS THERE A HOUSE MAP ?
NO
YES
191
IS A ROAD MAP BEING INDD. ?
NO
YES
192
STORE A REDUCED SCALE OF ROAD MAP
193
IND. A HOUSE MAP
194
SEARCH THE CURSOR POS.
199
SEARCH THE HOUSE SHAPE AT THE POS. OF CURSOR
200
IND. DETAILED DATA ?
NO
YES
202
IND. DETAILED DATA
195
IS THE HOUSE MAP BEING INDD.?
NO
YES
196
READ REDUCED SCALE DATA
197
IND. THE ROAD MAP
198
SEARCH THE CURSOR POS.
204
RETURN ?
YES
NO
206
REGISTER ?
NO
YES
208
REGISTER
STEP 52

FIG. 14

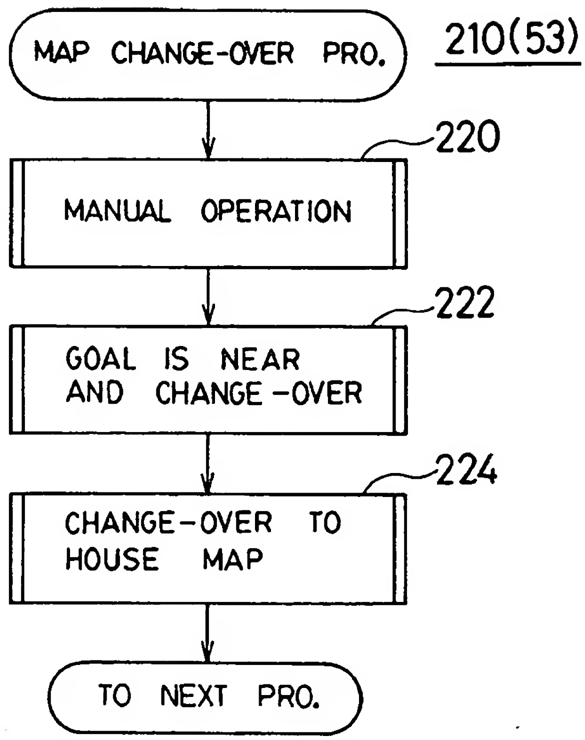

MAP CHANGE-OVER PRO.
210(53)
220
MANUAL OPERATION
222
GOAL IS NEAR AND CHANGE-OVER
224
CHANGE-OVER TO HOUSE MAP
TO NEXT PRO.

FIG. 15

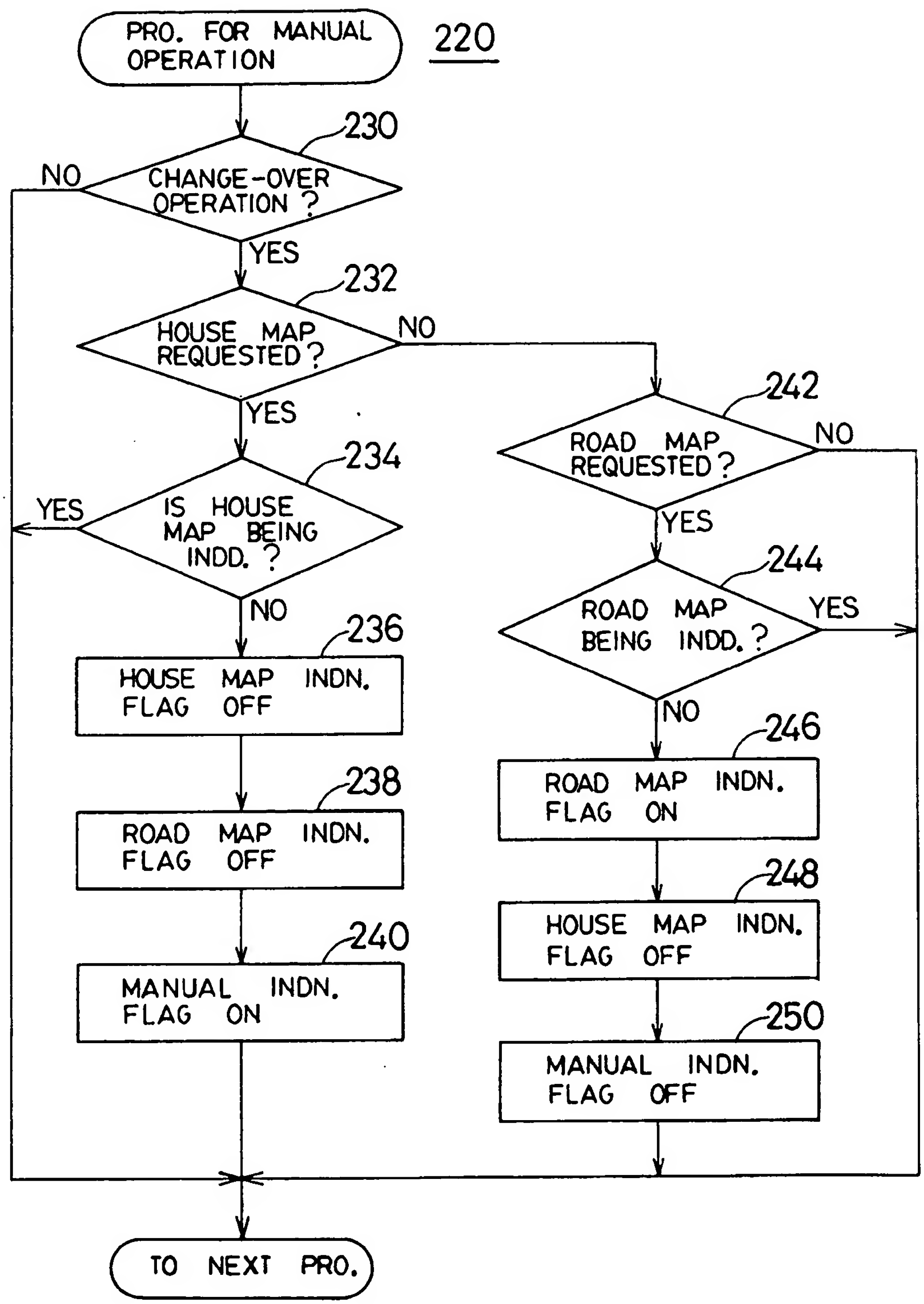

PRO. FOR MANUAL OPERATION
220
230
CHANGE-OVER OPERATION ?
NO
YES
232
HOUSE MAP REQUESTED ?
NO
YES
234
IS HOUSE MAP BEING INDD. ?
YES
NO
236
HOUSE MAP INDN. FLAG OFF
238
ROAD MAP INDN. FLAG OFF
240
MANUAL INDN. FLAG ON
242
ROAD MAP REQUESTED ?
NO
YES
244
ROAD MAP BEING INDD. ?
YES
NO
246
ROAD MAP INDN. FLAG ON
248
HOUSE MAP INDN. FLAG OFF
250
MANUAL INDN. FLAG OFF
TO NEXT PRO.

FIG. 16

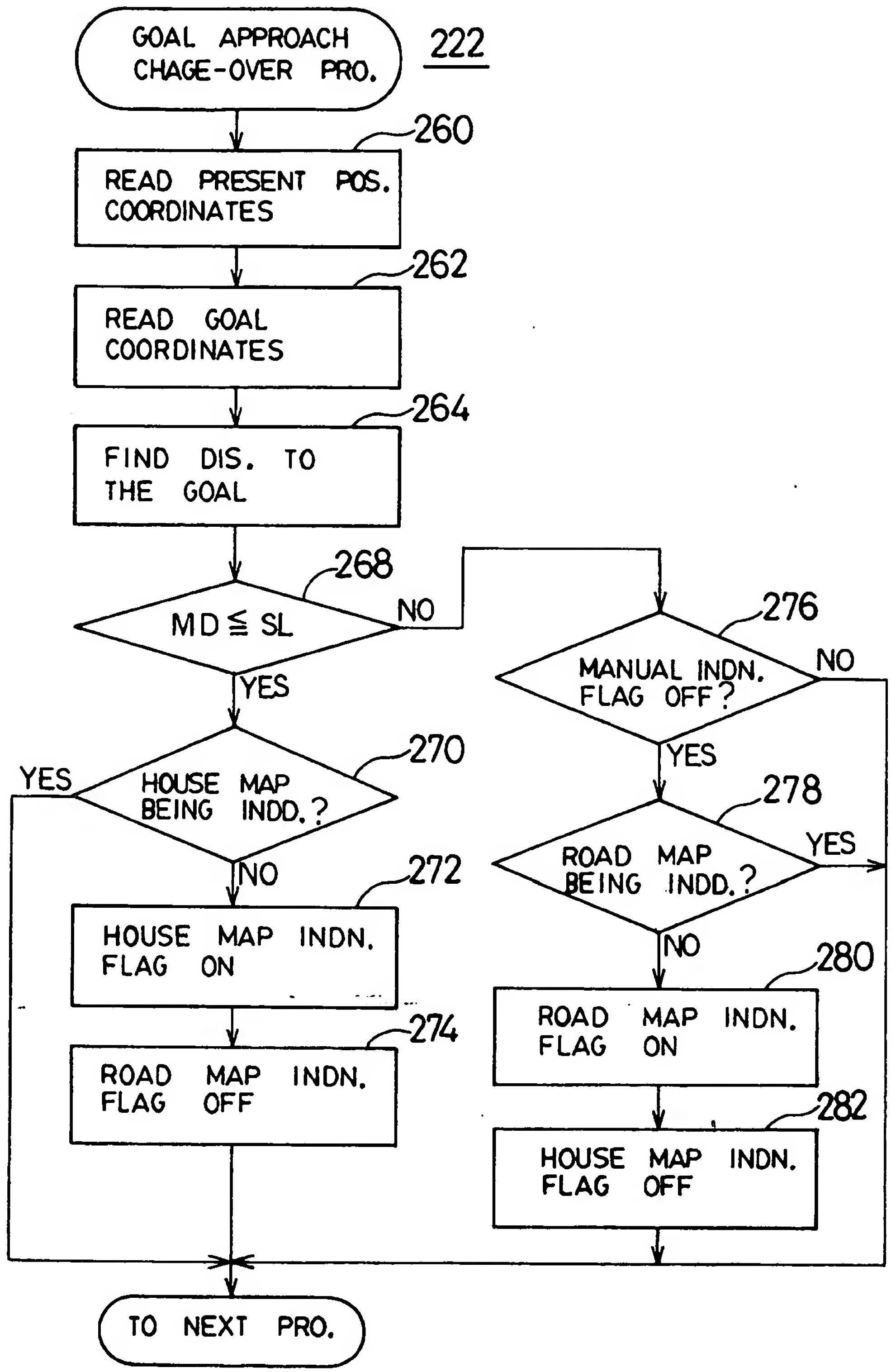

GOAL APPROACH CHAGE-OVER PRO.
222
260
READ PRESENT POS. COORDINATES
262
READ GOAL COORDINATES
264
FIND DIS. TO THE GOAL
268
MD ≦ SL
NO
YES
270
HOUSE MAP BEING INDD.?
YES
NO
272
HOUSE MAP INDN. FLAG ON
274
ROAD MAP INDN. FLAG OFF
276
MANUAL INDN. FLAG OFF?
NO
YES
278
ROAD MAP BEING INDD.?
YES
NO
280
ROAD MAP INDN. FLAG ON
282
HOUSE MAP INDN. FLAG OFF
TO NEXT PRO.

FIG. 17

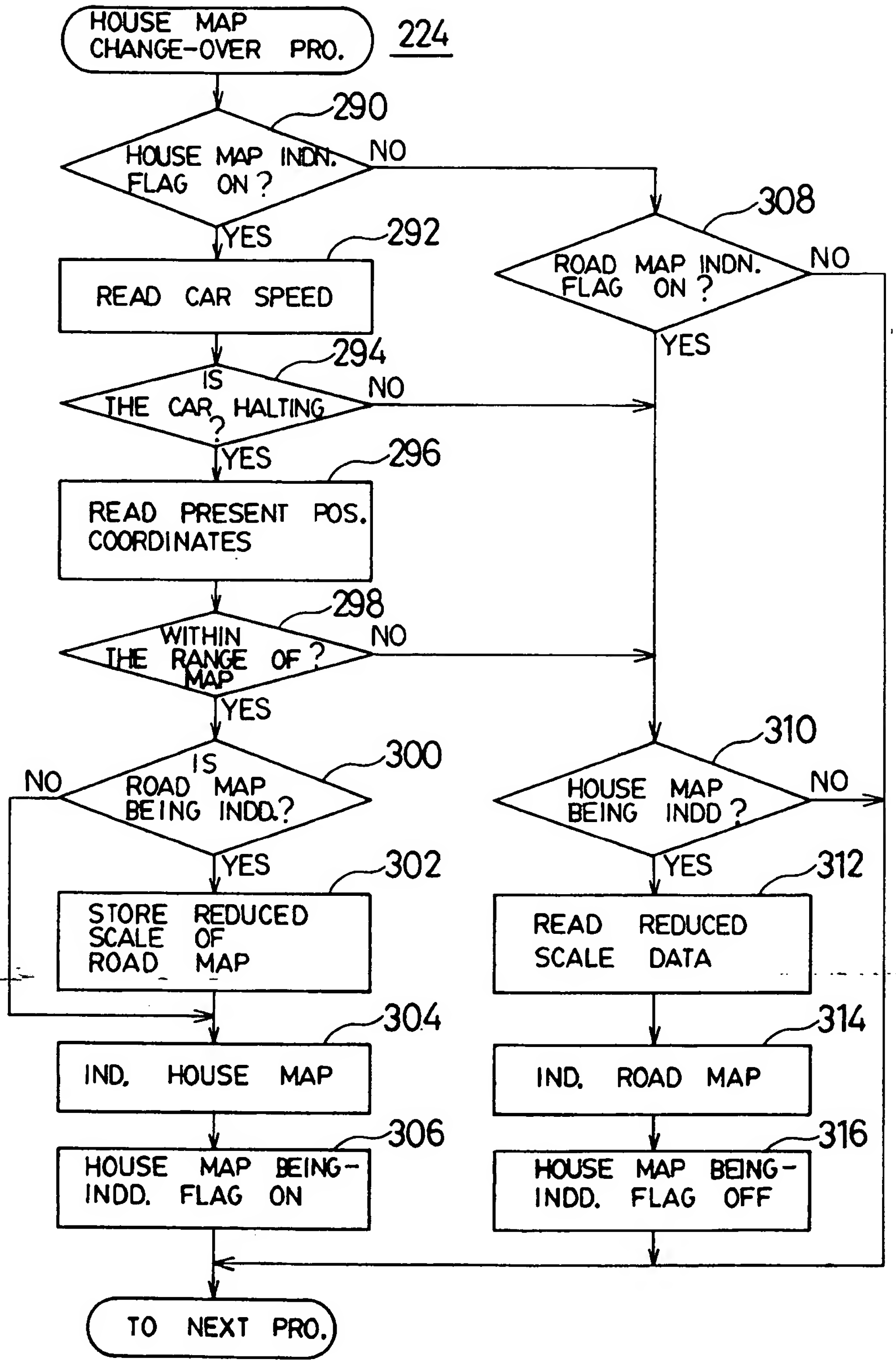

HOUSE MAP CHANGE-OVER PRO.
224
290
HOUSE MAP INDN. FLAG ON ?
NO
YES
292
READ CAR SPEED
294
IS THE CAR HALTING ?
NO
YES
296
READ PRESENT POS. COORDINATES
298
WITHIN THE RANGE OF MAP ?
NO
YES
300
IS ROAD MAP BEING INDD.?
NO
YES
302
STORE REDUCED SCALE OF ROAD MAP
304
IND. HOUSE MAP
306
HOUSE MAP BEING-INDD. FLAG ON
308
ROAD MAP INDN. FLAG ON ?
NO
YES
310
HOUSE MAP BEING INDD ?
NO
YES
312
READ REDUCED SCALE DATA
314
IND. ROAD MAP
316
HOUSE MAP BEING-INDD. FLAG OFF
TO NEXT PRO.

FIG. 18

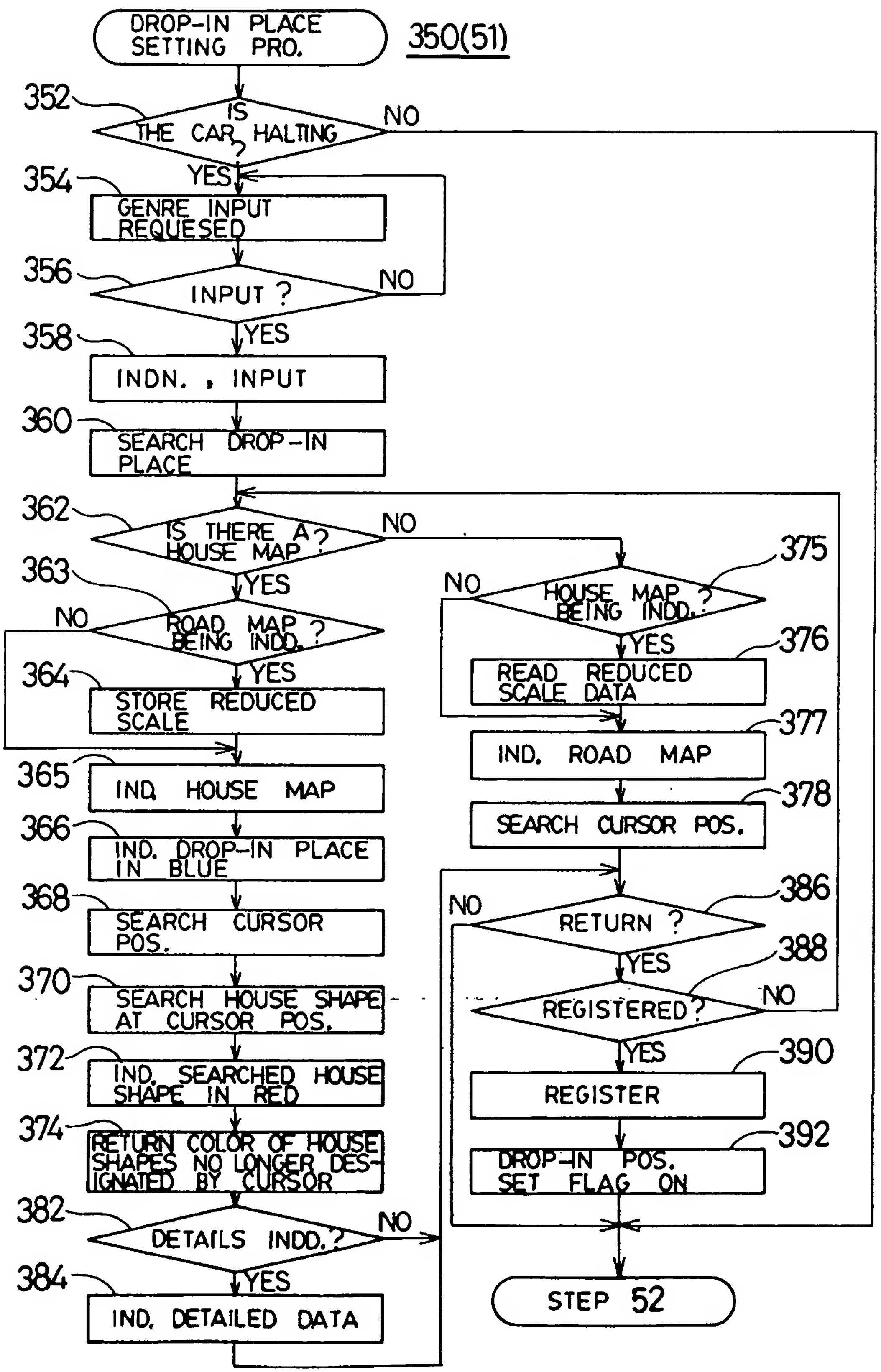

DROP-IN PLACE SETTING PRO.
350(51)
352
IS THE CAR HALTING?
NO
YES
354
GENRE INPUT REQUESED
356
INPUT ?
NO
358
YES
INDN. , INPUT
360
SEARCH DROP-IN PLACE
362
IS THERE A HOUSE MAP?
NO
363
YES
NO
ROAD MAP BEING INDD. ?
364
YES
STORE REDUCED SCALE
365
IND. HOUSE MAP
366
IND. DROP-IN PLACE IN BLUE
368
SEARCH CURSOR POS.
370
SEARCH HOUSE SHAPE AT CURSOR POS.
372
IND. SEARCHED HOUSE SHAPE IN RED
374
RETURN COLOR OF HOUSE SHAPES NO LONGER DESIGNATED BY CURSOR
382
DETAILS INDD.?
NO
384
YES
IND. DETAILED DATA
375
NO
HOUSE MAP BEING INDD.?
376
YES
READ REDUCED SCALE DATA
377
IND. ROAD MAP
378
SEARCH CURSOR POS.
386
NO
RETURN ?
388
YES
REGISTERED?
NO
YES
390
REGISTER
392
DROP-IN POS. SET FLAG ON
STEP 52

FIG. 19

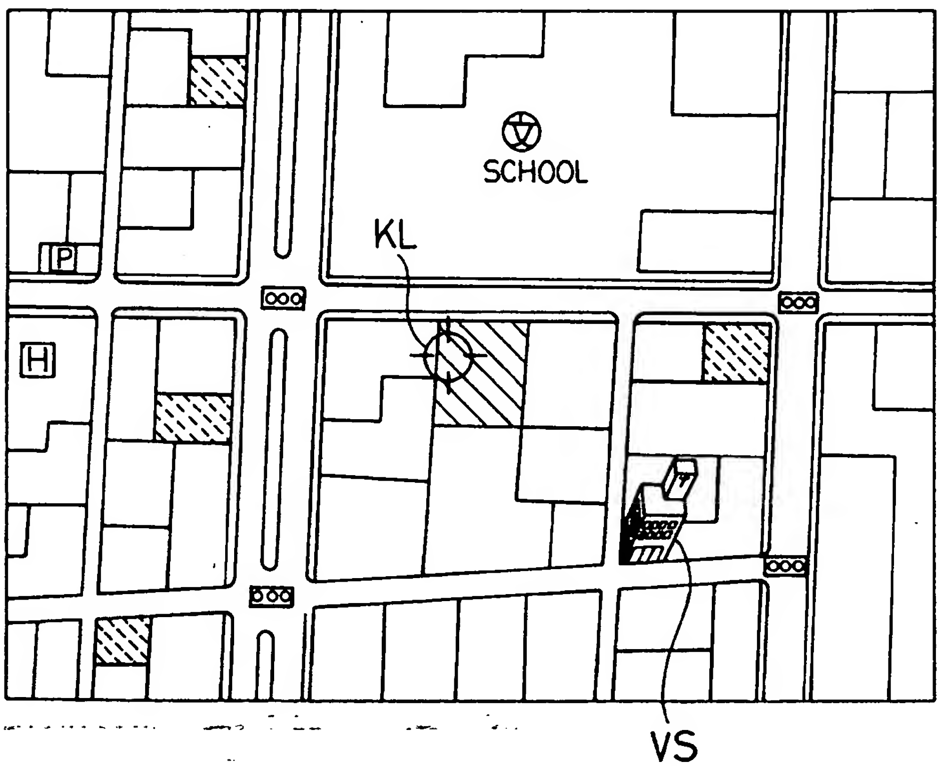


FIG. 20

RAM 4

EXTERNAL DATA	GD	PRESENT POS.	MP
ABSOLUTE DIR.	ZD	RELATIVE DIR. ANGLE	θ
DIS. TRAVELLED	ML	PRESENT POS. DATA	PI
VICS DATA	VD	ATIS DATA	AD
REGISTERED GOAL	TP	GUIDE ROUTE	MW
START POINT OF ROUTE	SP	END POINT OF ROUTE	EP
DROP-IN PLACE	DP	CONTINUING ROAD No.	LN
DIR. OF GOAL	MH		

DESIGNATED POS.	IZ	PAR. ADJACENT ROAD No.	SN

ADJACENT ROADS	LD

FIG. 21

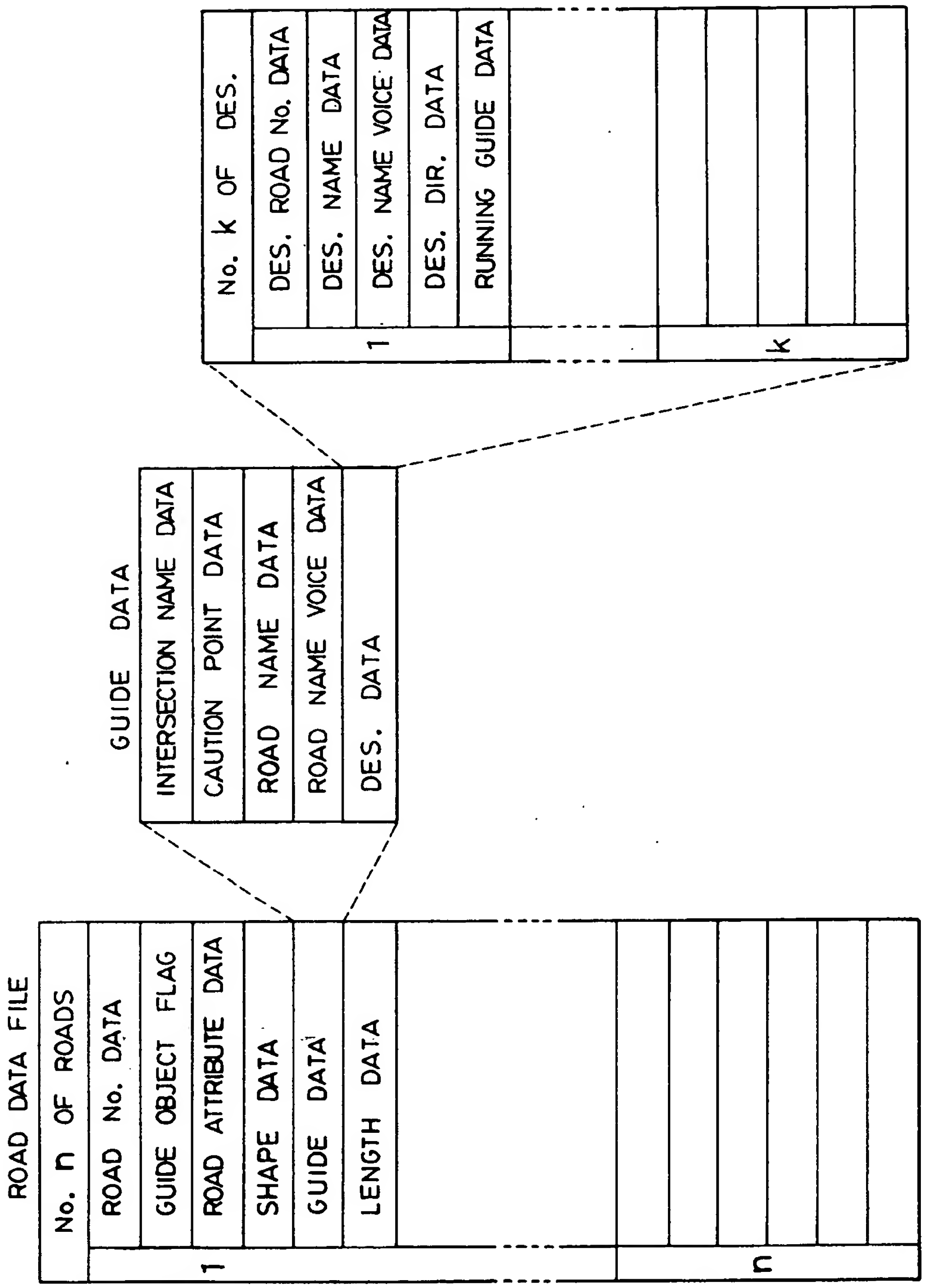

ROAD DATA FILE
No. n OF ROADS
ROAD No. DATA
GUIDE OBJECT FLAG
ROAD ATTRIBUTE DATA
SHAPE DATA
GUIDE DATA
LENGTH DATA
1
n
GUIDE DATA
INTERSECTION NAME DATA
CAUTION POINT DATA
ROAD NAME DATA
ROAD NAME VOICE DATA
DES. DATA
No. k OF DES.
DES. ROAD No. DATA
DES. NAME DATA
DES. NAME VOICE DATA
DES. DIR. DATA
RUNNING GUIDE DATA
1
k

FIG. 22

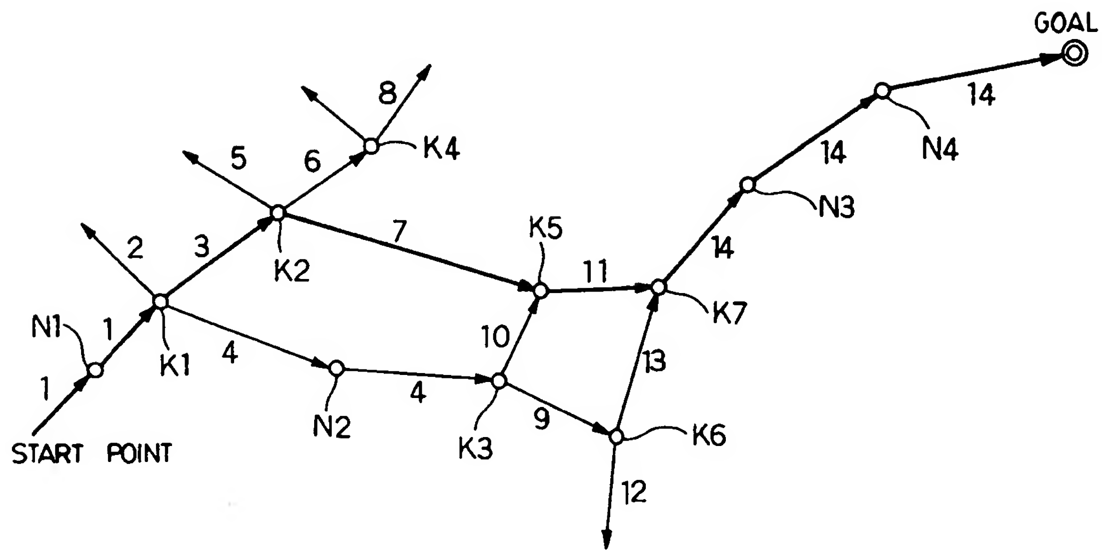

GOAL
8
K4
5
6
14
N4
14
N3
7
K5
2
3
14
K2
11
K7
N1
1
10
K1
4
13
1
4
9
K6
START POINT
N2
K3
12

FIG. 23

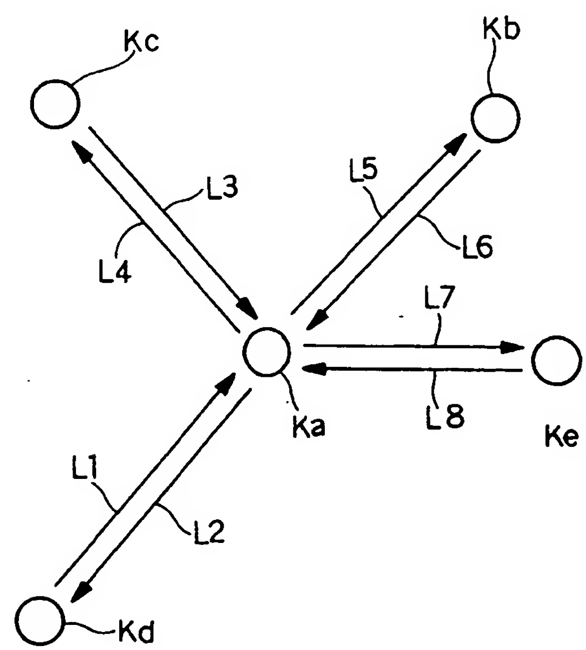

Kc
Kb
L3
L5
L4
L6
L7
Ka
L8
Ke
L1
L2
Kd

FIG. 24

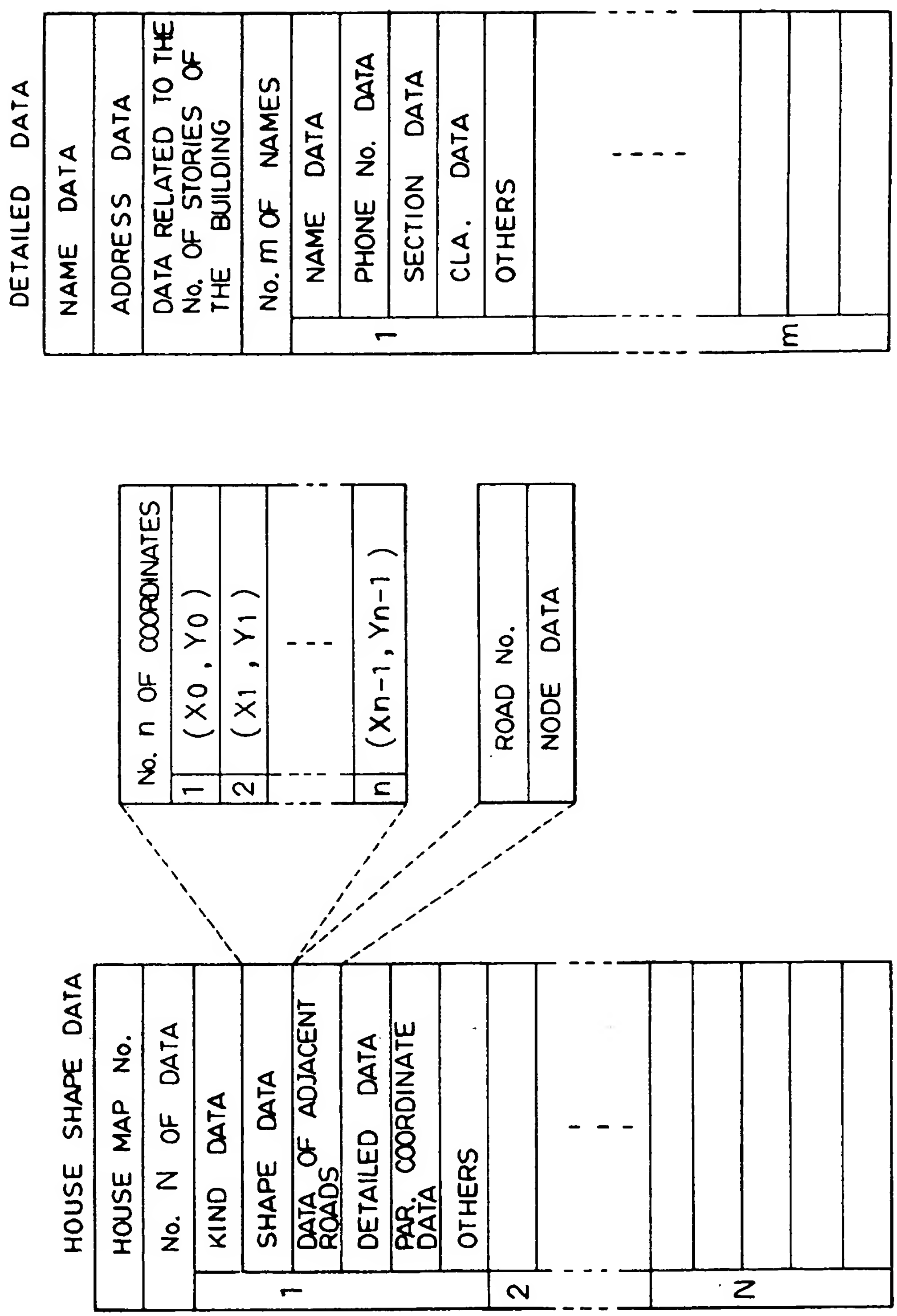

HOUSE SHAPE DATA
HOUSE MAP No.
No. N OF DATA
KIND DATA
SHAPE DATA
DATA OF ADJACENT ROADS
DETAILED DATA
PAR. COORDINATE DATA
OTHERS
1
2
N
No. n OF COORDINATES
(X0 , Y0)
(X1 , Y1)
(Xn-1 , Yn-1)
1
2
n
ROAD No.
NODE DATA
DETAILED DATA
NAME DATA
ADDRESS DATA
DATA RELATED TO THE No. OF STORIES OF THE BUILDING
No. m OF NAMES
NAME DATA
PHONE No. DATA
SECTION DATA
CLA. DATA
OTHERS
1
m

FIG. 25

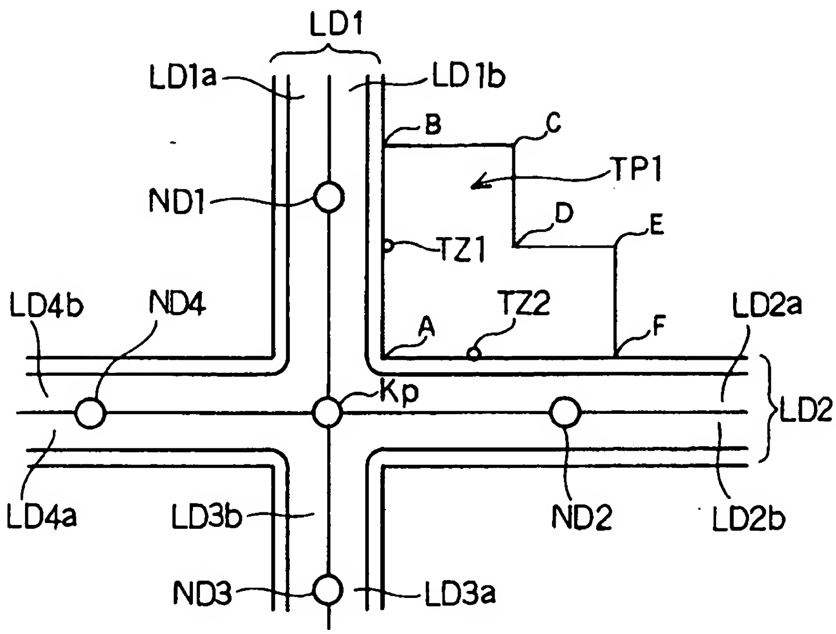

LD1
LD1a
LD1b
B
C
TP1
ND1
D
E
TZ1
LD4b
ND4
A
TZ2
F
LD2a
Kp
LD2
LD4a
LD3b
ND2
LD2b
ND3
LD3a

FIG. 26

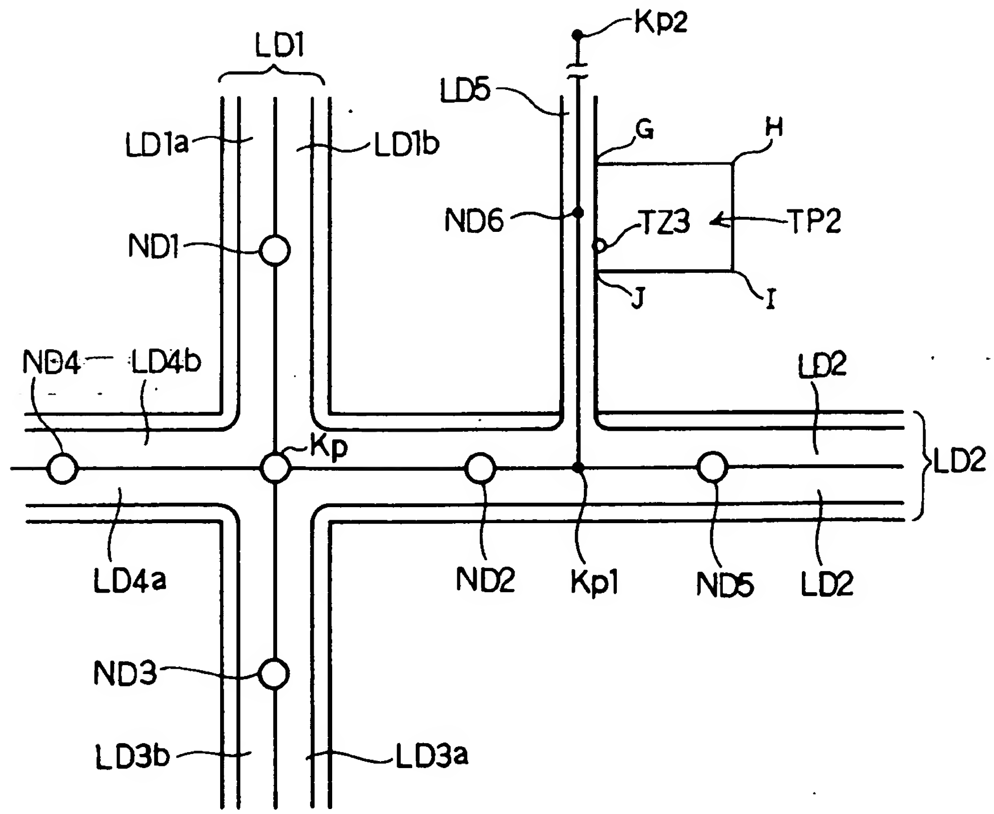

Kp2
LD1
LD5
G
H
LD1a
LD1b
ND6
TZ3
TP2
ND1
J
I
ND4
LD4b
LD2
Kp
LD2
LD4a
ND2
Kp1
ND5
LD2
ND3
LD3b
LD3a

FIG. 27

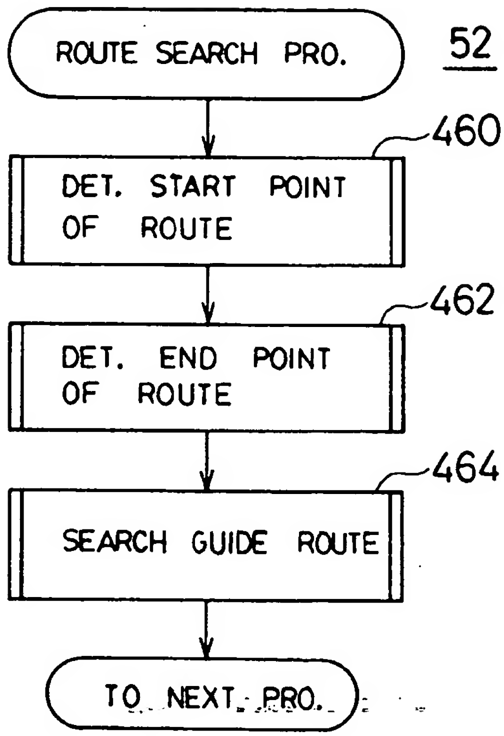

ROUTE SEARCH PRO.
52
460
DET. START POINT OF ROUTE
462
DET. END POINT OF ROUTE
464
SEARCH GUIDE ROUTE
TO NEXT PRO.

FIG. 28

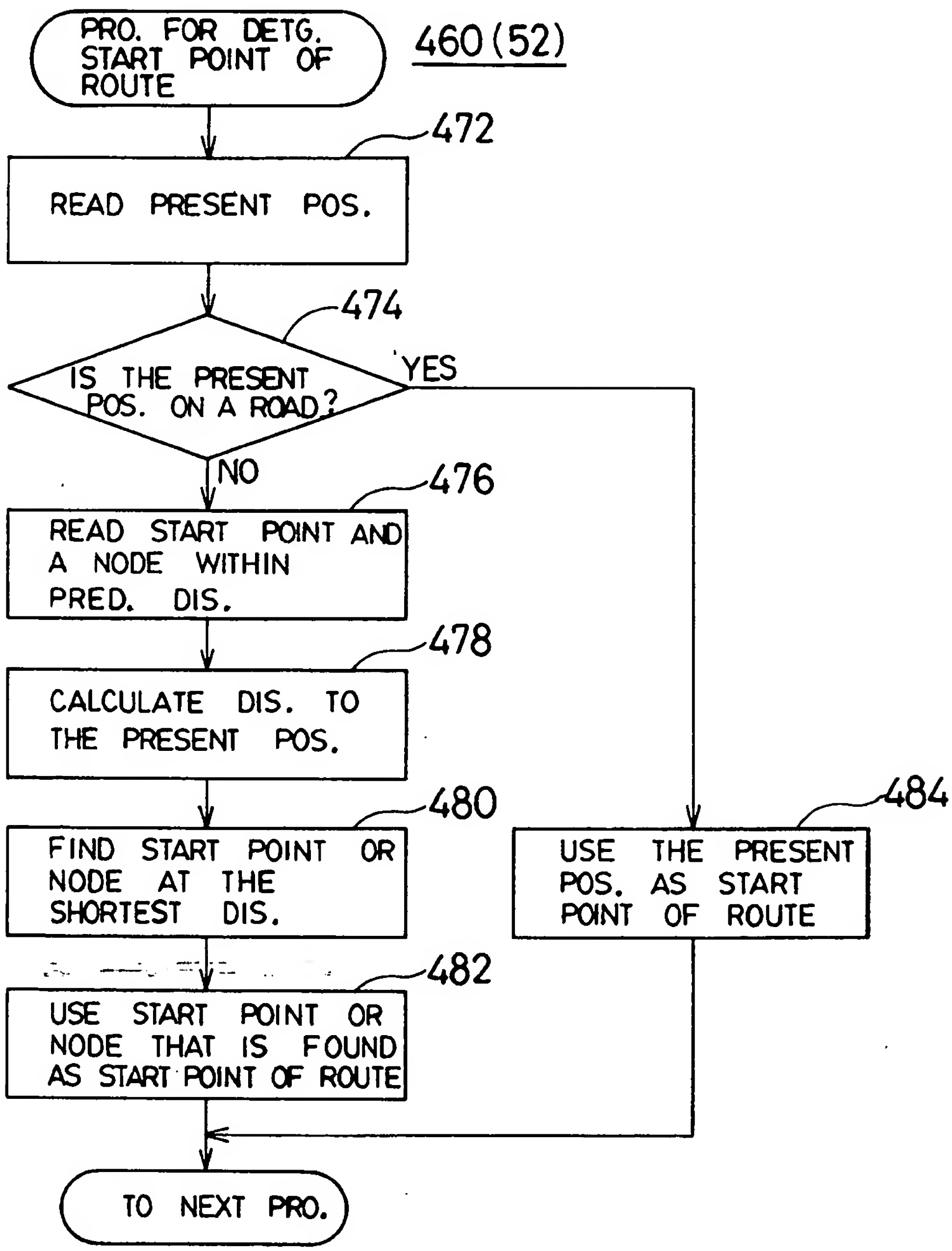

PRO. FOR DETG. START POINT OF ROUTE
460(52)
472
READ PRESENT POS.
474
IS THE PRESENT POS. ON A ROAD?
YES
NO
476
READ START POINT AND A NODE WITHIN PRED. DIS.
478
CALCULATE DIS. TO THE PRESENT POS.
480
FIND START POINT OR NODE AT THE SHORTEST DIS.
482
USE START POINT OR NODE THAT IS FOUND AS START POINT OF ROUTE
484
USE THE PRESENT POS. AS START POINT OF ROUTE
TO NEXT PRO.

FIG. 29

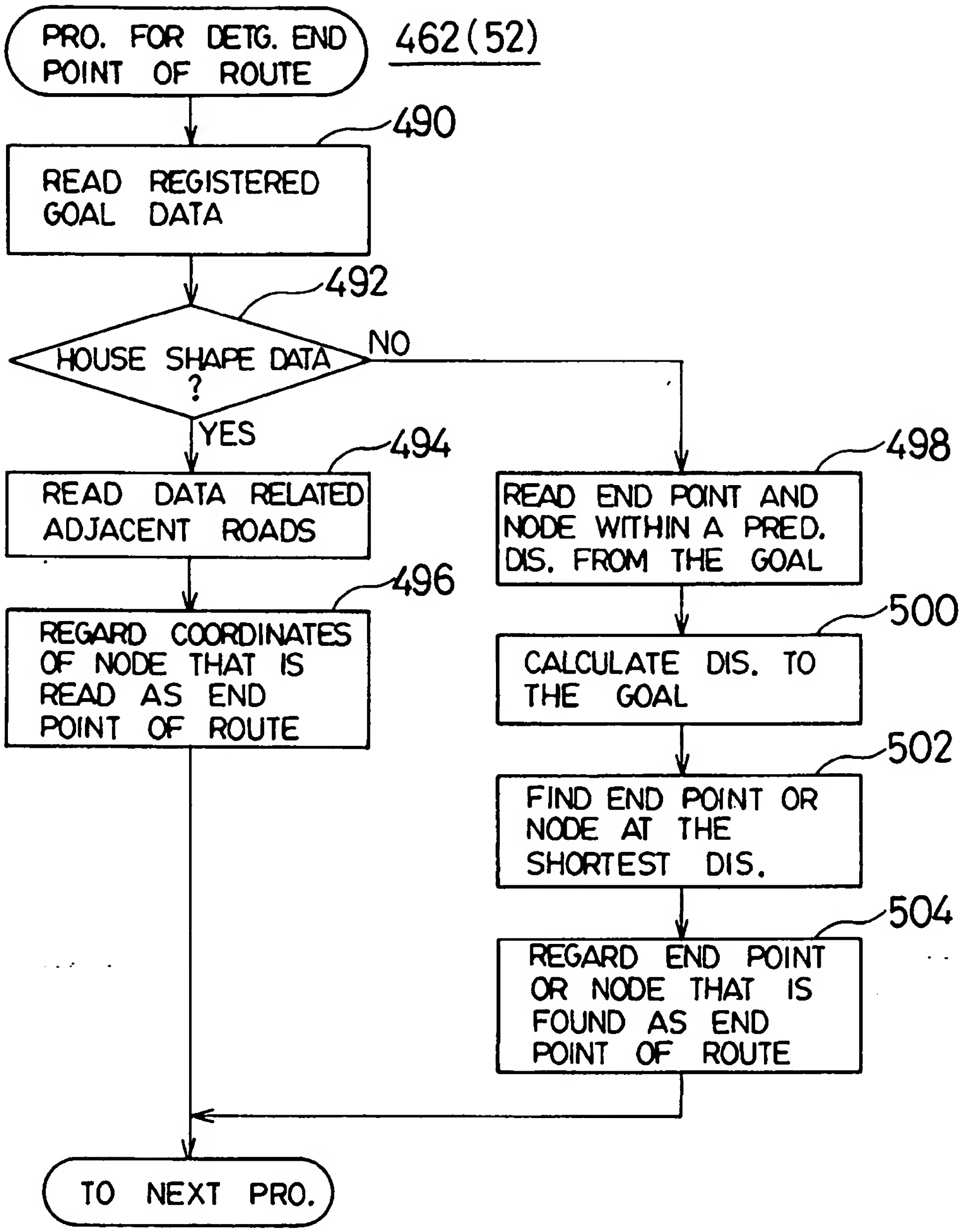

PRO. FOR DETG. END POINT OF ROUTE
462(52)
490
READ REGISTERED GOAL DATA
492
HOUSE SHAPE DATA ?
NO
YES
494
READ DATA RELATED ADJACENT ROADS
496
REGARD COORDINATES OF NODE THAT IS READ AS END POINT OF ROUTE
498
READ END POINT AND NODE WITHIN A PRED. DIS. FROM THE GOAL
500
CALCULATE DIS. TO THE GOAL
502
FIND END POINT OR NODE AT THE SHORTEST DIS.
504
REGARD END POINT OR NODE THAT IS FOUND AS END POINT OF ROUTE
TO NEXT PRO.

FIG. 30

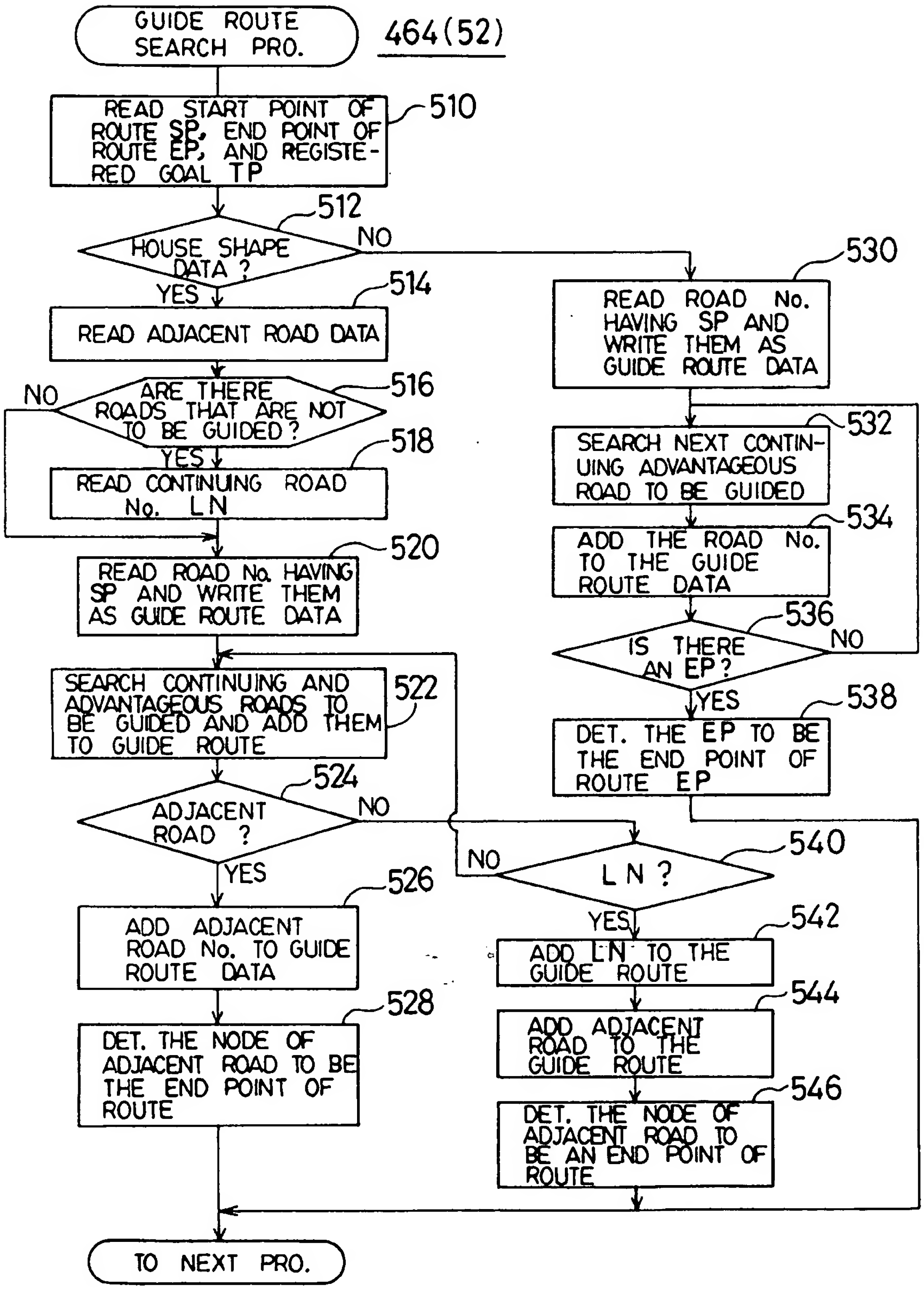

GUIDE ROUTE SEARCH PRO.
464(52)
READ START POINT OF ROUTE SP, END POINT OF ROUTE EP, AND REGISTERED GOAL TP
510
HOUSE SHAPE DATA ?
512
NO
YES
READ ADJACENT ROAD DATA
514
ARE THERE ROADS THAT ARE NOT TO BE GUIDED?
516
NO
YES
READ CONTINUING ROAD No. LN
518
READ ROAD No. HAVING SP AND WRITE THEM AS GUIDE ROUTE DATA
520
SEARCH CONTINUING AND ADVANTAGEOUS ROADS TO BE GUIDED AND ADD THEM TO GUIDE ROUTE
522
ADJACENT ROAD ?
524
NO
YES
ADD ADJACENT ROAD No. TO GUIDE ROUTE DATA
526
DET. THE NODE OF ADJACENT ROAD TO BE THE END POINT OF ROUTE
528
READ ROAD No. HAVING SP AND WRITE THEM AS GUIDE ROUTE DATA
530
SEARCH NEXT CONTINUING ADVANTAGEOUS ROAD TO BE GUIDED
532
ADD THE ROAD No. TO THE GUIDE ROUTE DATA
534
IS THERE AN EP?
536
NO
YES
DET. THE EP TO BE THE END POINT OF ROUTE EP
538
LN ?
540
NO
YES
ADD LN TO THE GUIDE ROUTE
542
ADD ADJACENT ROAD TO THE GUIDE ROUTE
544
DET. THE NODE OF ADJACENT ROAD TO BE AN END POINT OF ROUTE
546
TO NEXT PRO.

FIG. 31

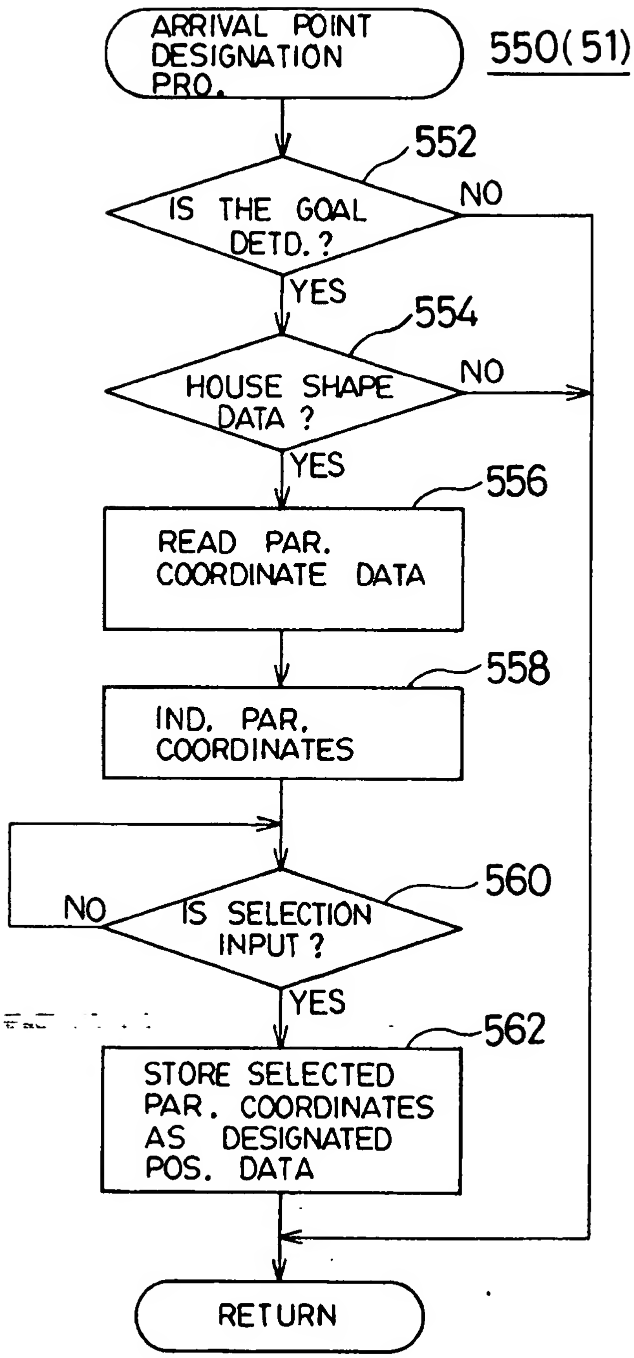

ARRIVAL POINT DESIGNATION PRO.
550(51)
552
IS THE GOAL DETD. ?
NO
YES
554
HOUSE SHAPE DATA ?
NO
YES
556
READ PAR. COORDINATE DATA
558
IND. PAR. COORDINATES
560
NO
IS SELECTION INPUT ?
YES
562
STORE SELECTED PAR. COORDINATES AS DESIGNATED POS. DATA
RETURN

FIG. 32

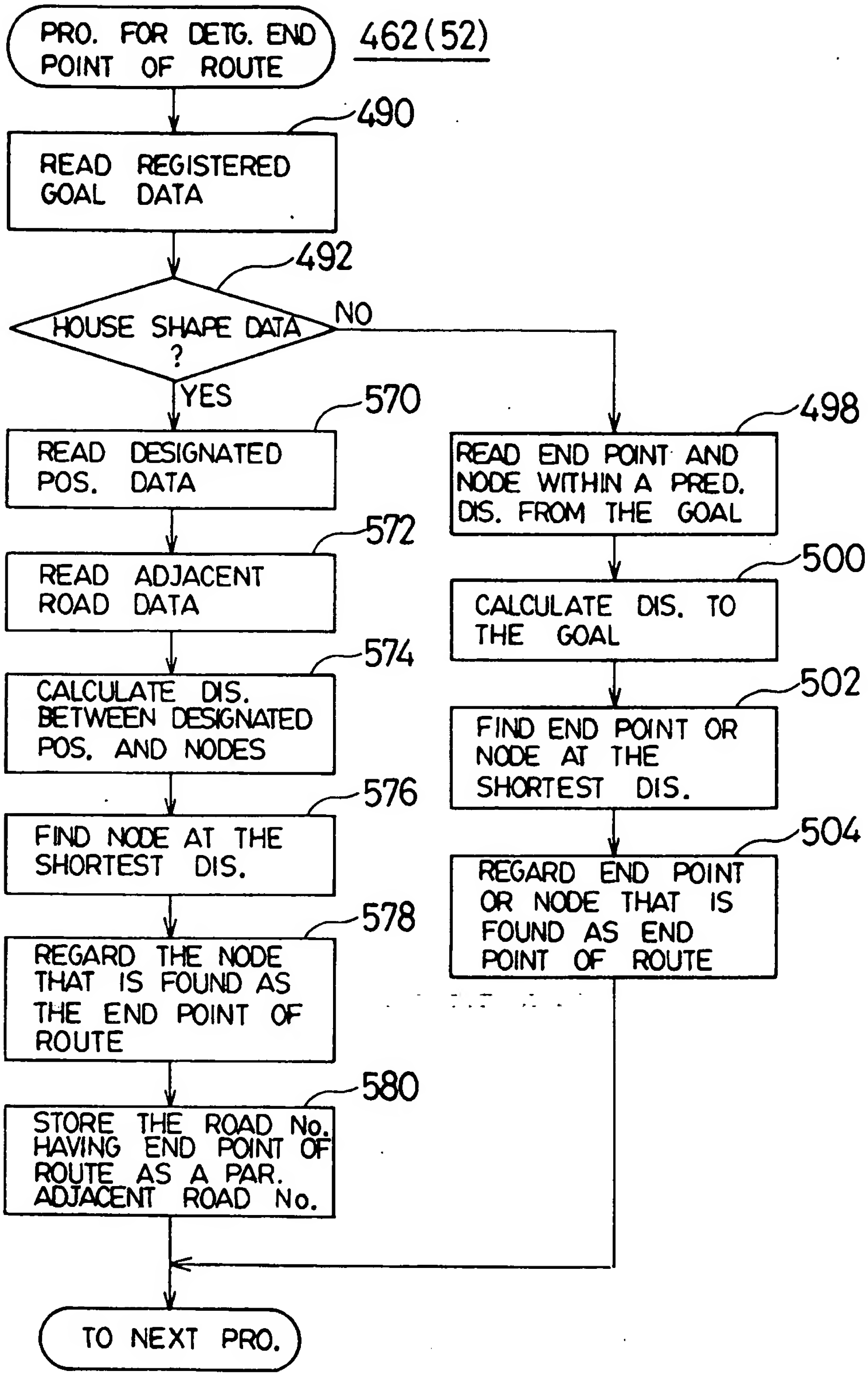

PRO. FOR DETG. END POINT OF ROUTE
462(52)
490
READ REGISTERED GOAL DATA
492
HOUSE SHAPE DATA ?
NO
YES
570
READ DESIGNATED POS. DATA
572
READ ADJACENT ROAD DATA
574
CALCULATE DIS. BETWEEN DESIGNATED POS. AND NODES
576
FIND NODE AT THE SHORTEST DIS.
578
REGARD THE NODE THAT IS FOUND AS THE END POINT OF ROUTE
580
STORE THE ROAD No. HAVING END POINT OF ROUTE AS A PAR. ADJACENT ROAD No.
498
READ END POINT AND NODE WITHIN A PRED. DIS. FROM THE GOAL
500
CALCULATE DIS. TO THE GOAL
502
FIND END POINT OR NODE AT THE SHORTEST DIS.
504
REGARD END POINT OR NODE THAT IS FOUND AS END POINT OF ROUTE
TO NEXT PRO.

FIG. 33

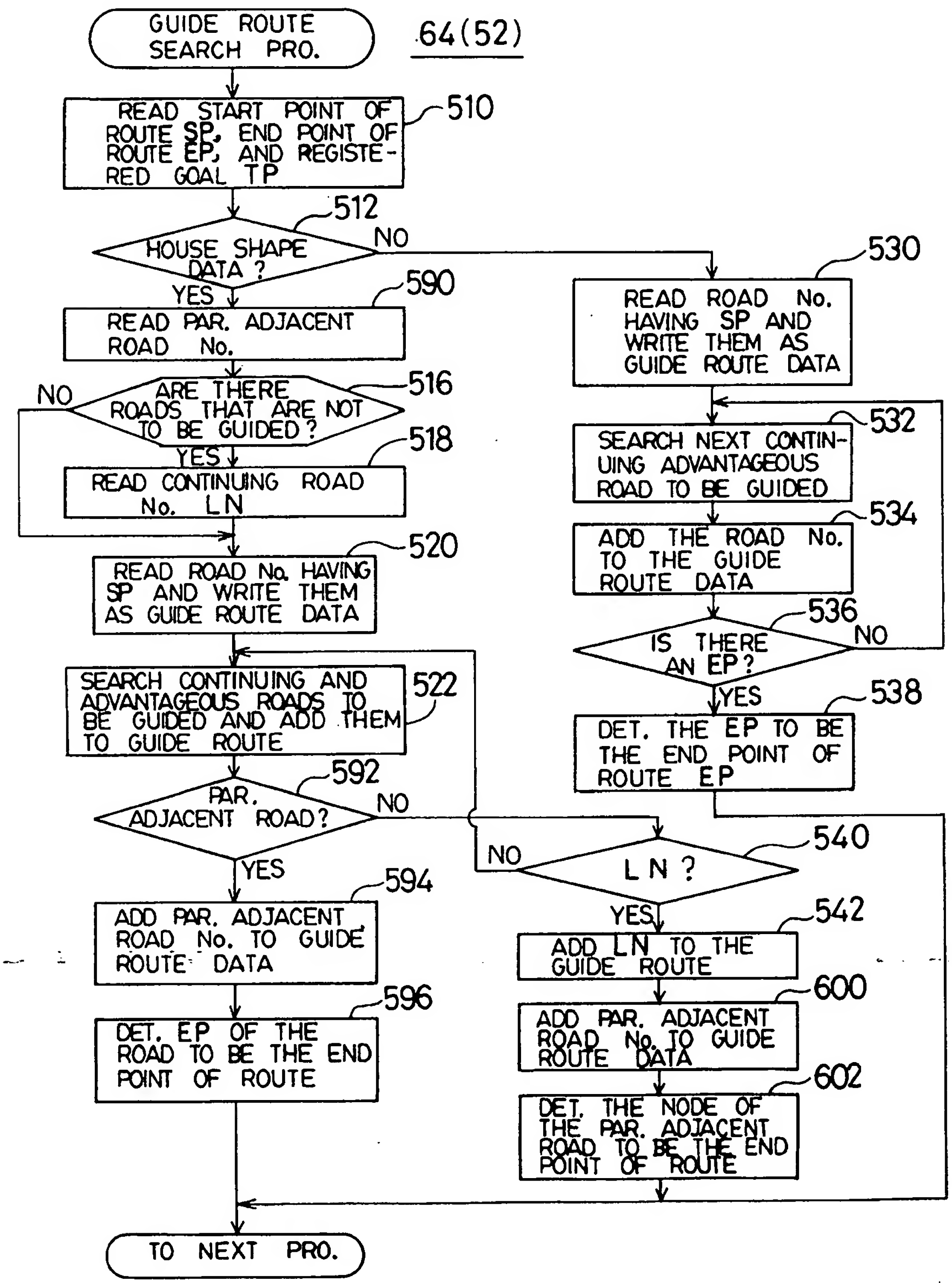

GUIDE ROUTE SEARCH PRO.
64(52)
READ START POINT OF ROUTE SP, END POINT OF ROUTE EP, AND REGISTERED GOAL TP
510
HOUSE SHAPE DATA ?
512
NO
YES
READ PAR. ADJACENT ROAD No.
590
ARE THERE ROADS THAT ARE NOT TO BE GUIDED ?
516
NO
YES
READ CONTINUING ROAD No. LN
518
READ ROAD No. HAVING SP AND WRITE THEM AS GUIDE ROUTE DATA
520
SEARCH CONTINUING AND ADVANTAGEOUS ROADS TO BE GUIDED AND ADD THEM TO GUIDE ROUTE
522
PAR. ADJACENT ROAD?
592
NO
YES
ADD PAR. ADJACENT ROAD No. TO GUIDE ROUTE DATA
594
DET. EP OF THE ROAD TO BE THE END POINT OF ROUTE
596
READ ROAD No. HAVING SP AND WRITE THEM AS GUIDE ROUTE DATA
530
SEARCH NEXT CONTINUING ADVANTAGEOUS ROAD TO BE GUIDED
532
ADD THE ROAD No. TO THE GUIDE ROUTE DATA
534
IS THERE AN EP?
536
NO
YES
DET. THE EP TO BE THE END POINT OF ROUTE EP
538
L N ?
540
NO
YES
ADD LN TO THE GUIDE ROUTE
542
ADD PAR. ADJACENT ROAD No. TO GUIDE ROUTE DATA
600
DET. THE NODE OF THE PAR. ADJACENT ROAD TO BE THE END POINT OF ROUTE
602
TO NEXT PRO.

FIG. 34

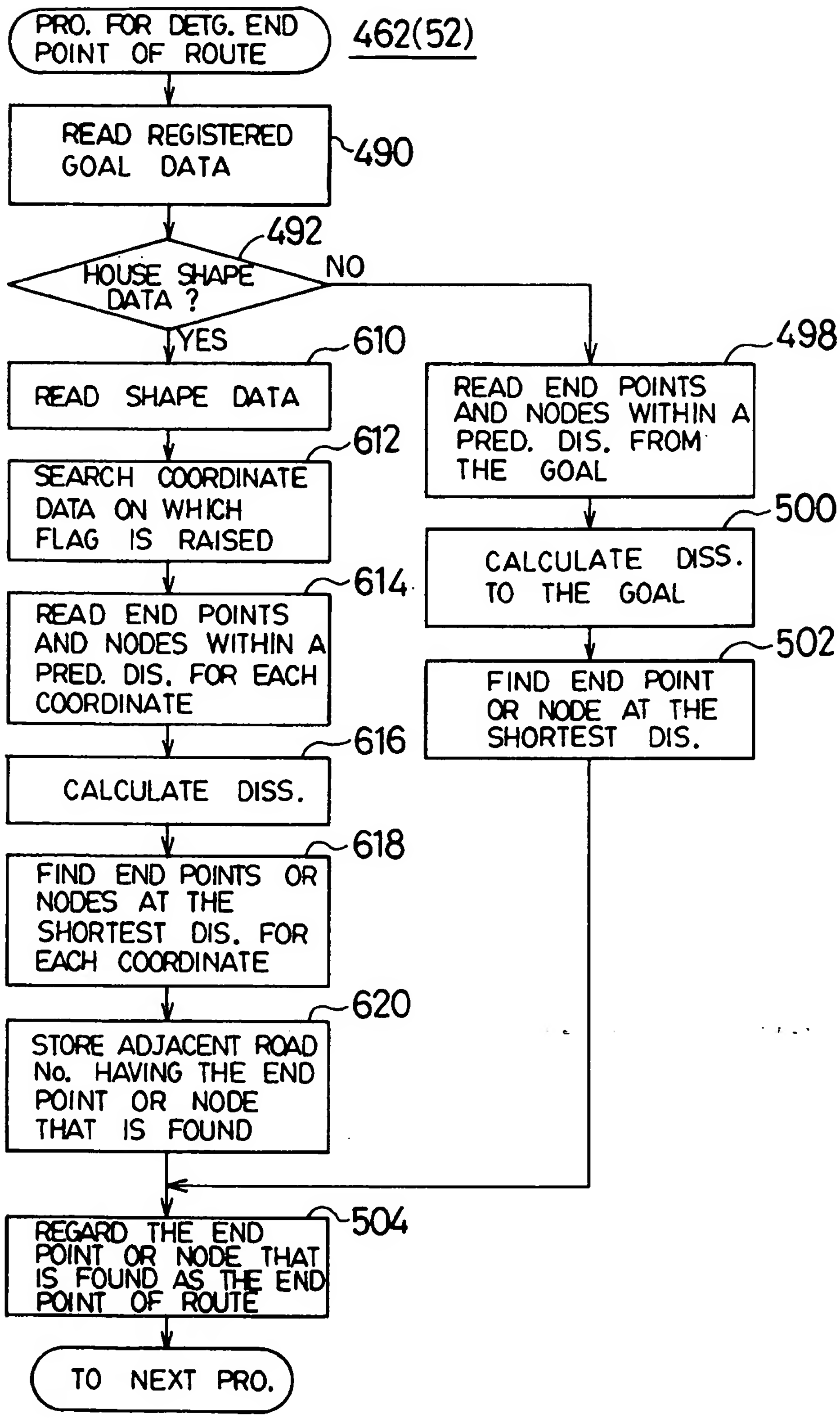

PRO. FOR DETG. END POINT OF ROUTE
462(52)
READ REGISTERED GOAL DATA
490
492
HOUSE SHAPE DATA ?
NO
YES
610
READ SHAPE DATA
612
SEARCH COORDINATE DATA ON WHICH FLAG IS RAISED
614
READ END POINTS AND NODES WITHIN A PRED. DIS. FOR EACH COORDINATE
616
CALCULATE DISS.
618
FIND END POINTS OR NODES AT THE SHORTEST DIS. FOR EACH COORDINATE
620
STORE ADJACENT ROAD No. HAVING THE END POINT OR NODE THAT IS FOUND
498
READ END POINTS AND NODES WITHIN A PRED. DIS. FROM THE GOAL
500
CALCULATE DISS. TO THE GOAL
502
FIND END POINT OR NODE AT THE SHORTEST DIS.
504
REGARD THE END POINT OR NODE THAT IS FOUND AS THE END POINT OF ROUTE
TO NEXT PRO.

FIG. 35

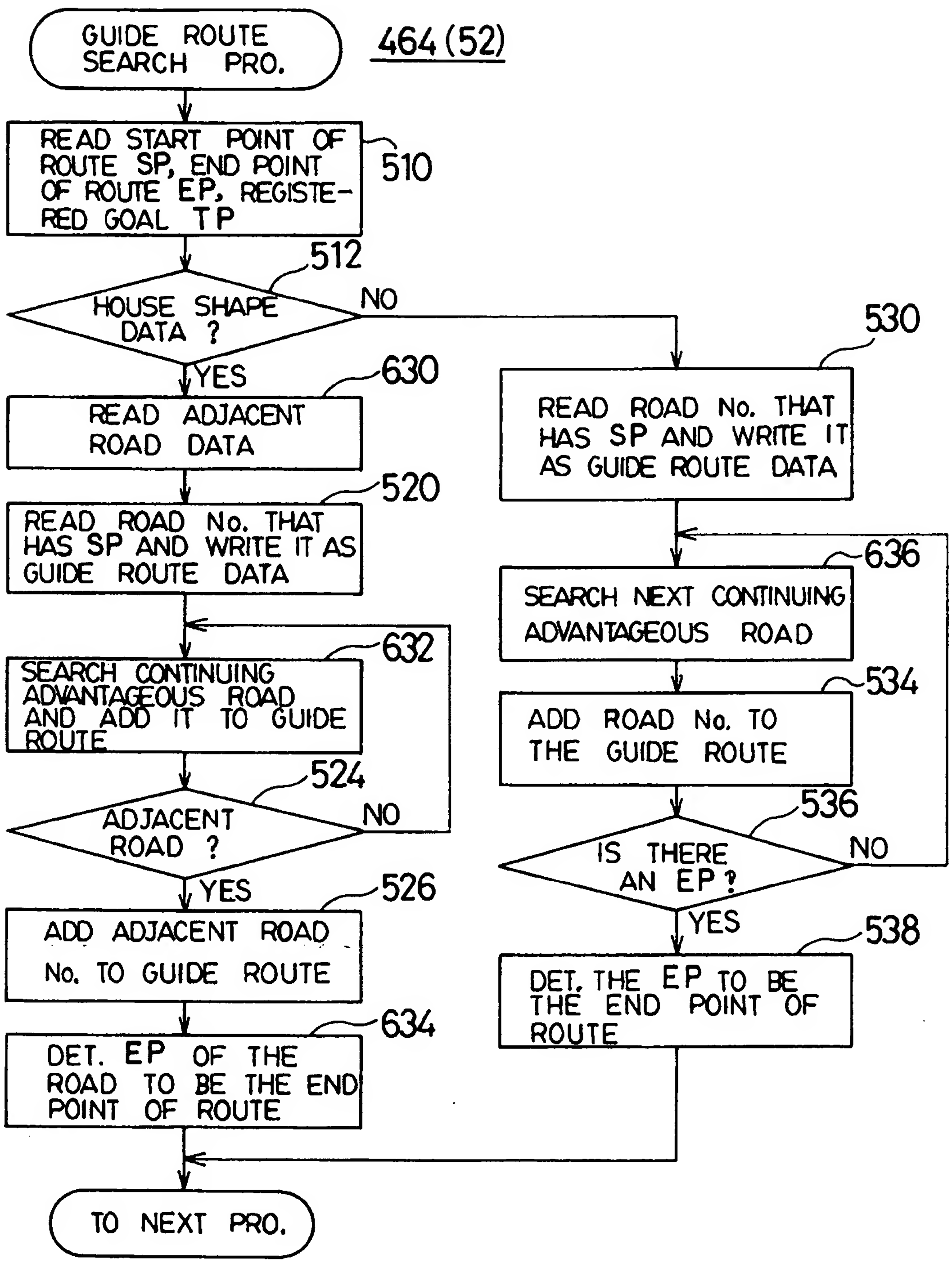

GUIDE ROUTE SEARCH PRO.
464 (52)
READ START POINT OF ROUTE SP, END POINT OF ROUTE EP, REGISTERED GOAL TP
510
512
HOUSE SHAPE DATA ?
NO
YES
630
READ ADJACENT ROAD DATA
520
READ ROAD No. THAT HAS SP AND WRITE IT AS GUIDE ROUTE DATA
632
SEARCH CONTINUING ADVANTAGEOUS ROAD AND ADD IT TO GUIDE ROUTE
524
ADJACENT ROAD ?
NO
YES
526
ADD ADJACENT ROAD No. TO GUIDE ROUTE
634
DET. EP OF THE ROAD TO BE THE END POINT OF ROUTE
530
READ ROAD No. THAT HAS SP AND WRITE IT AS GUIDE ROUTE DATA
636
SEARCH NEXT CONTINUING ADVANTAGEOUS ROAD
534
ADD ROAD No. TO THE GUIDE ROUTE
536
IS THERE AN EP ?
NO
YES
538
DET. THE EP TO BE THE END POINT OF ROUTE
TO NEXT PRO.

FIG. 36

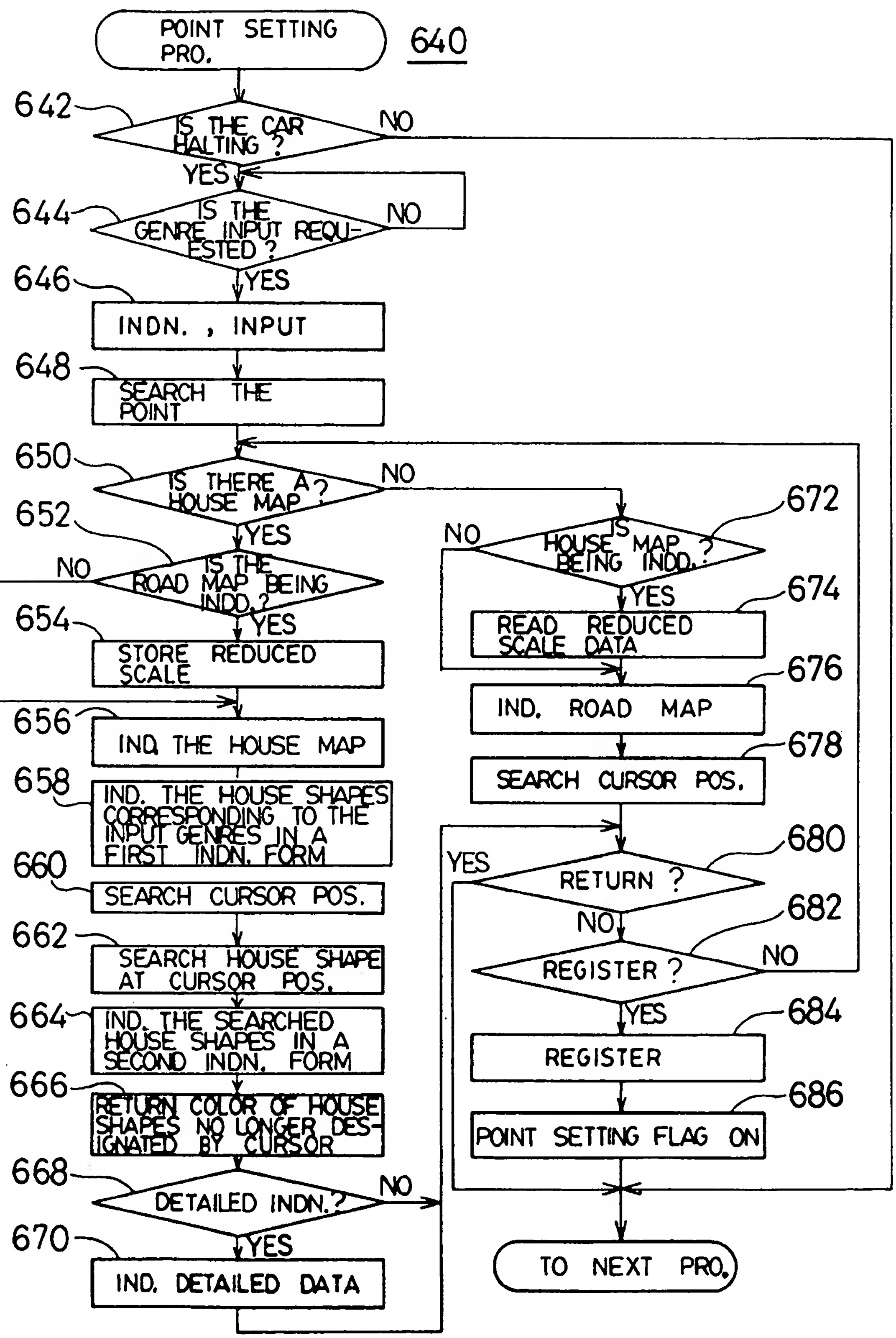
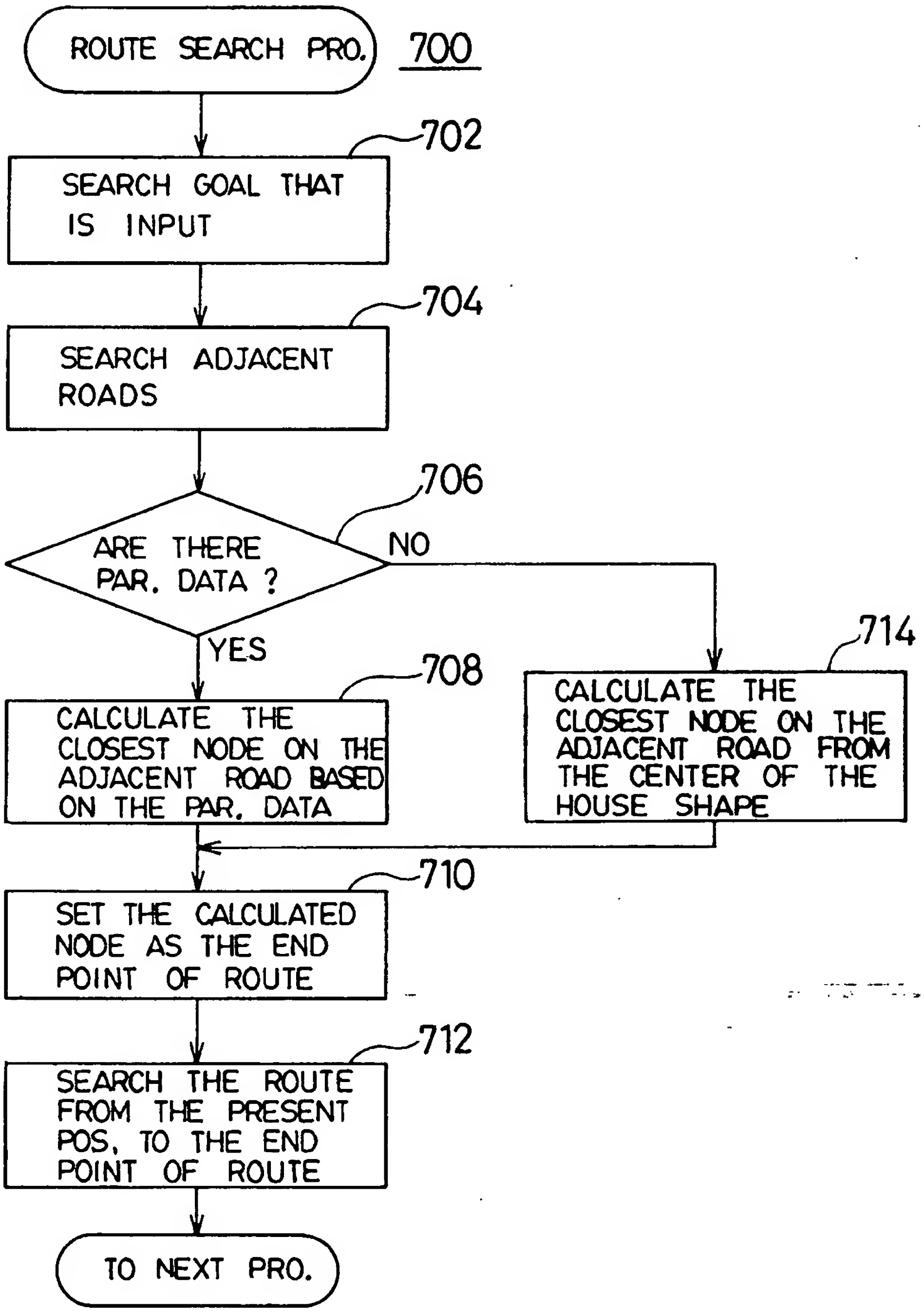

POINT SETTING PRO.
640
642
IS THE CAR HALTING ?
NO
YES
644
IS THE GENRE INPUT REQUESTED ?
NO
646
YES
INDN. , INPUT
648
SEARCH THE POINT
650
IS THERE A HOUSE MAP ?
NO
652
YES
NO
IS THE ROAD MAP BEING INDD.?
654
YES
STORE REDUCED SCALE
656
IND. THE HOUSE MAP
658
IND. THE HOUSE SHAPES CORRESPONDING TO THE INPUT GENRES IN A FIRST INDN. FORM
660
SEARCH CURSOR POS.
662
SEARCH HOUSE SHAPE AT CURSOR POS.
664
IND. THE SEARCHED HOUSE SHAPES IN A SECOND INDN. FORM
666
RETURN COLOR OF HOUSE SHAPES NO LONGER DESIGNATED BY CURSOR
668
DETAILED INDN.?
NO
670
YES
IND. DETAILED DATA
672
NO
IS HOUSE MAP BEING INDD.?
674
YES
READ REDUCED SCALE DATA
676
IND. ROAD MAP
678
SEARCH CURSOR POS.
680
YES
RETURN ?
682
NO
REGISTER ?
NO
YES
684
REGISTER
686
POINT SETTING FLAG ON
TO NEXT PRO.

FIG. 37


ROUTE SEARCH PRO.
700
702
SEARCH GOAL THAT IS INPUT
704
SEARCH ADJACENT ROADS
706
ARE THERE PAR. DATA ?
NO
YES
708
CALCULATE THE CLOSEST NODE ON THE ADJACENT ROAD BASED ON THE PAR. DATA
714
CALCULATE THE CLOSEST NODE ON THE ADJACENT ROAD FROM THE CENTER OF THE HOUSE SHAPE
710
SET THE CALCULATED NODE AS THE END POINT OF ROUTE
712
SEARCH THE ROUTE FROM THE PRESENT POS. TO THE END POINT OF ROUTE
TO NEXT PRO.

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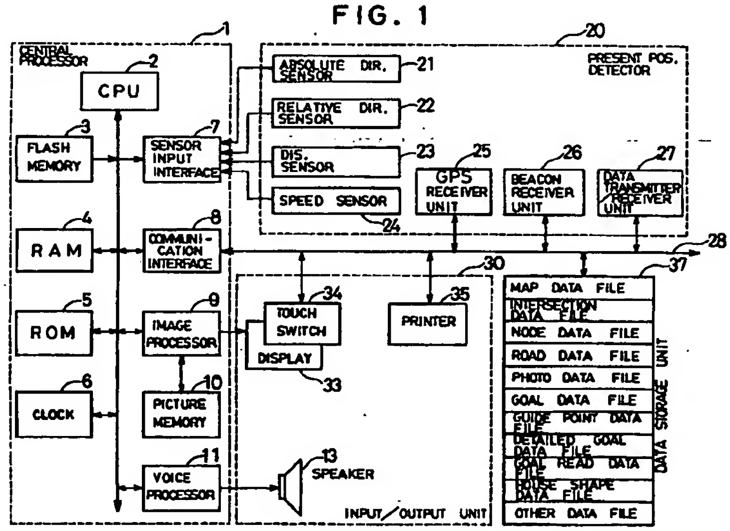
(54) Map indication device and navigation device

(57) Upon recognizing the shapes of buildings, buildings can be searched and destinations can be designated simply and easily. Besides, indication of the house map and the road map is changed over depending upon the predetermined conditions. This makes it easy to arrive at the destination. When the destination is indicated on the house map, a guide route is searched up to a position on a road adjacent to the building at the destination. This makes it easy to learn where in the vicinity of the destination the car is arriving at.

FIG. 1



EP 0 766 217 A3

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EUROPEAN SEARCH REPORT

Application Number
EP 96 11 5646

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 539 146 A (PIONEER ELECTRONIC CORPORATION) 28 April 1993 * abstract * * column 1, line 44 - column 2, line 51 * * column 3, line 35 - column 4, line 9 * * column 5, line 7-44 * * column 6, line 43 - column 8, line 12; figures 1,3,6-8 * ---	1-4, 7-10,12, 13,15,19	G08G1/137 G08G1/0969 G01C21/20
X A	EP 0 306 088 A (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) 8 March 1989 * abstract * * column 1, line 49 - column 2, line 16 * * column 4, line 22 - column 8, line 43; figures 3A,3B,4 * ---	1-3,5, 15,19 6,7,14	
X A	EP 0 508 787 A (PIONEER ELECTRONIC CORPORATION) 14 October 1992 * abstract * * column 1, line 42 - column 2, line 42 * * column 4, line 12 - column 5, line 37 * * column 5, line 50 - column 6, line 27 * * column 7, line 1-52; figures 2-4 * ---	1-3,5, 15,19 6,7,14	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
X A	US 5 107 433 A (HELLDÖRFER ET AL.) 21 April 1992 * abstract * * column 2, line 56 - column 4, line 33 * * column 12, line 21 - column 15, line 22; figures 1-3,18-20 * ---	1-7,15 14	G08G G01C G06T G09B
A	US 5 289 572 A (YANO ET AL.) 22 February 1994 * abstract * * column 2, line 47 - column 4, line 5 * * column 4, line 23-32; figures 2,3A-3G * --- -/--	1-4,8,9, 15,18	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	30 June 1998	Beitner, M

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X : particularly relevant if taken alone
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& : member of the same patent family, corresponding document

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EUROPEAN SEARCH REPORT

Application Number
EP 96 11 5646

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 4 974 170 A (BOUVE ET AL.) 27 November 1990 * abstract * * column 2, line 60 - column 3, line 11; figures 2,6 * ---	1,3,4	
A	DE 42 19 171 A (MITSUBISHI DENKI K.K.) 14 January 1993 * abstract * * column 3, line 9-58 * * column 6, line 17 - column 7, line 5; figures 2,3,6-8 * ---	4	
A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 14 (P-1672), 11 January 1994 & JP 05 250420 A (NIPPON TELEGR & TELEPH CORP), 18 September 1993, * abstract * ---	1-3,5	
A	PATENT ABSTRACTS OF JAPAN vol. 15, no. 356 (P-1249), 9 September 1991 & JP 03 137681 A (MITSUBISHI ELECTRIC CORP), 12 June 1991, * abstract * ---	1-7,10, 12,15	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 195 (P-1039), 20 April 1990 & JP 02 038813 A (SUZUKI MOTOR CO LTD), 8 February 1990, * abstract * -----	1,2,7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	30 June 1998	Beitner, M

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